

PAL User Manual

Installation and Operation

HTS PAL / HTX PAL

PAL HTS-*xt* / PAL HTX-*xt*

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Original Instructions

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A. Safety Information

General Considerations



The PAL System User Manual and the corresponding “Addendum” for a specific module must be consulted by the user under all circumstances before a unit is put in use.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.

The user shall be made aware that, if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

When using the PAL System, follow the generally accepted procedures for quality control and methods development.

When using the PAL System in the field of chromatographic analysis, if a change in the retention of a particular compound, in the resolution between two compounds, or in peak shape is observed, immediately determine the reason for the changes. Do not rely on the separation results until you determine the cause of a change.

Electrical Hazards



Every analytical instrument has specific hazards, so be sure to read and comply with the following precautions. They will help ensure the safe, long-term use of your PAL System.

The installation category (over-voltage category) for this instrument is Level II. The Level II category pertains to equipment that receives its electrical power from the local level, such as an electrical wall outlet.



Use only fuses of the type and current rating specified. Do not use repaired fuses and do not short-circuit the fuse holder.

The supplied power cord must be inserted into a power outlet with a protective earth contact (ground). When using an extension cord, make sure that the cord also has an earth contact.



Do not change the external or internal grounding connections. Tampering with or disconnecting these connections could endanger you and/or damage the PAL System.

The instrument is properly grounded in accordance with these regulations when shipped. You do not need to make any changes to the electrical connections or the instrument's chassis to ensure safe operation.



The combination of a PAL System with a LC/MS System does require the safety measure as described by the LC/MS System manufacturer. Detailed instructions for the safety grounding on the LC/MS system are outlined in the corresponding operating/installation manual.

CTC Analytics recommends using a grounding cable connected on one side at the Injection Valve, Loop or any other suitable direct metallic contact, and on the other side at an appropriate ground point on the LC/MS System. This supplementary grounding measure will support the safety strategy of the LC/MS System manufacturer.



Do not turn the instrument on if you suspect that it has incurred any kind of electrical damage. Instead disconnect the power cord and contact a CTC Analytics representative for a product evaluation. Do not attempt to use the instrument until it has been evaluated. Electrical damage may have occurred if the PAL System shows visible signs of damage, exposure to any liquids or has been transported under severe stress.



Damage can also result if the instrument is stored for prolonged periods under unfavorable conditions (e.g. subjected to heat, water, etc.). Ensure that the power supply/controller unit is always placed on a dry and clean position. Avoid any spill of liquids.



Always disconnect the power cord(s) from the power supply or from the various power supplies if optional devices are installed before attempting any type of maintenance.
Capacitors inside the instrument may still be charged even if the instrument is turned off.

To avoid damaging electrical parts, do not disconnect an electrical assembly while power is applied to the PAL system. Once the power is turned off, wait approximately 30 seconds before you disconnect an assembly.



The instrument includes a number of integrated circuits. These circuits may be damaged if exposed to excessive line voltage fluctuations and/or power surges.



Never try to repair or replace any components of the instrument that are not described in this manual without the assistance of a CTC Analytics representative.

There are no operator-serviceable or replaceable parts inside the power supply(ies) or in the PAL System. If a power supply is not functioning, contact a CTC Analytics representative.



The power supplies for the PAL Instrument, the Stack Cooler DW, Stack Cooler MT and Tray Cooler have the symbols I/O on the label for the power switch to switch ON/OFF.

Any additional power supply for other devices, such as a Valve Module, exhibits the symbols shown below on the label for the power switch:



Power ON



Power OFF

The symbols warn the user that in an emergency more than one power supply must be turned OFF or more than one power cord must be pulled from the power supply or from the wall outlet to shut down the complete PAL System.

If the basic PAL System is installed, then a single power supply only is installed. Turning OFF the power supply or pulling this single power cord in an emergency case will stop the complete PAL System.

If a Stack Cooler DW, Stack Cooler MT or a Tray Cooler is installed in combination with a PAL System, then a second power supply is installed in the complete system. Turning OFF the power supplies or pulling the two power cords will stop the complete PAL System in an emergency.

It is important that the power supply (ies) be in a location where the power ON and OFF switch is accessible and easy to operate, and where it is possible to unplug the AC power cord from the power supply/wall outlet in case of emergency.

Other Hazards



To avoid injury during PAL System operation, keep your hands away from the syringe.



Do not operate the PAL System without the safety shield. The safety shield must be installed for safe operation.



To avoid injury, observe safe laboratory practice when handling solvents, changing tubing, or operating the PAL System. Know the physical and chemical properties of the solvents you use. See the Material Safety Data Sheets from the manufacturer of the solvents being used.



Use caution when working with any polymer tubing under pressure:

- Always wear eye protection when near pressurized polymer tubing.
- Do not use polymer tubing that has been severely stressed or kinked.
- Do not use polymer tubing, in particular no PEEK or Tefzel tubing when using tetrahydrofuran (THF), dimethylsulfoxid (DMSO), chlorinated organic solvents, concentrated mineral acids, such as nitric, phosphoric or sulfuric acids, or any compounds related to the above.



Do not use vials without a sealing cap, microtiter or deepwell plates without a plate seal. Vapor phase from organic solvents can be hazardous and flammable. Acidic vapor phase can cause corrosion to critical mechanical parts.

Disposal



Do not dispose of this equipment or parts thereof unsorted in municipal waste. Follow local municipal waste ordinances for proper disposal provisions to reduce the environmental impact of waste electrical and electronic equipment (WEEE).

European Union customers: Call your local customer service representative responsible for the PAL System for complimentary equipment pick-up and recycling.

Commonly Used Symbols

	Caution or refer to User Manual
	Caution, Risk of Needle-Stick Puncture
	Caution, Hot Surface or High Temperature
	Direct Current
	Alternating Current
	Protective Conductor Terminal, Ground
	Fuse
	Electrical Power ON Used with Main PAL Power Supply
	Electrical Power OFF Used with Main PAL Power Supply
	Electrical Power ON for Only Part of the System. Used with Optional Device(s)
	Electrical Power OFF for Only Part of the System Used with Optional Device(s)
	Caution, Risk of Electrical shock (high voltage)
	Disposal, Do not dispose in municipal waste. Follow local waste regulations to reduce electrical and electronic waste (WEEE).

B. Table of Contents

A. Safety Information	2
B. Table of Contents	7
C. List of Figures	10
D. How to Use this Manual	12
E. HTS PAL Operating Instructions	13
1. Using the Control Terminal	13
1.1. Menu Screens	13
1.2. Function Keys	14
1.3. ESCape and STOP Keys	14
1.4. Scroll Knob and ENTER Button	14
2. Methods	15
2.1. Creating Methods	15
2.2. Edit / View Methods	16
2.3. Delete Methods	16
3. Job and Job Queue	17
3.1. Building and Starting a Job Queue	17
3.2. Aborting a Job Queue	18
3.3. Restarting an aborted Job Queue	19
4. Utility Functions	19
4.1. Syringe	20
4.2. Tray	21
4.3. Injector	22
4.4. Wash Station	22
4.5. Vial	23
4.6. Dilutors	23
4.7. Tools	24
5. Logfile	24
6. Info Functions	25
6.1. Hardware	25
6.2. Software	25
6.3. Maintenance	26
6.4. Free Objects / Free Items	26
7. Setup Functions	26
7.1. Sounds	27
7.2. Time	27
7.3. Objects	27

F. HTS PAL Description and Installation	28
1. General System Overview	28
1.1. Specifications	29
1.3. Electrical Specifications	30
1.4. Physical Specifications	31
1.5. Operating and Environmental Requirements	31
1.6. Sound Pressure Level	31
1.7. Hardware and Software Requirements	32
1.8. Regulatory Compliance Requirements	32
2. Product Warranty	33
2.1. Statement of Limited Product Warranty	33
3. Installation	35
3.1. Unpacking the Components	35
3.2. Assembling the HTS PAL	35
3.3. Electrical Connections	45
4. HTS PAL Object Positions	46
4.1. Defining Object Positions	46
4.2. Description of Object Positions	49
5. Syringes	55
5.1. Selecting Syringes	55
5.2. Syringe Priming	56
5.3. Installing a Syringe	56
5.4. Removing a Syringe	57
6. Injection Valve	58
6.1. Valve Drives and Valves – General Remarks	58
6.2. Injection Valve Flow Path	59
7. Interfacing the HTS PAL to Other Devices	67
7.1. Synchronization and Output Signals	67
8. PAL Software Program	69
8.1. PAL Loader Program	69
8.2. PAL Object Manager Software	70
9. Establishing Communication with Computer	71
9.1. COM Port Settings	71
9.2. Setting up LAN Communication	72
9.3. Troubleshooting for Serial or LAN Communication	75
10. Special Functions	76
10.1. How to Access “Extended User Mode”	76
10.2. Section Extended User Mode or “F3-Setup”	77
10.3. Section “F3-Setup” / Objects	81

G. Troubleshooting PAL and PAL-<i>xt</i> System	89
H. Replacing Parts	91
1. MOTIO Board	91
2. CPU Board	93
3. Control- <i>xt</i> Board	94
4. Injection Valve and Valve Rotor	95
4.1. Injection Valve	95
4.2. Replacing Valve Rotor	98
5. Injection Unit	102
6. Wash Station	102
I. Maintaining the PAL System	103
J. Appendices	104
1. Definition of Terms	104
2. Naming Convention	107
3. HTS PAL and - <i>xt</i> Injection Cycles	108
3.1. HTS PAL and - <i>xt</i> "LC-Inj" Cycle	108
3.2. HTS PAL and - <i>xt</i> "LC-Cut" Cycle	110
4. PAL Firmware Overview	113
4.1. HTS PAL Flow Chart based on PAL Firmware Version 2.5.X.	113
4.2. PAL HTS- <i>xt</i> System Flow Chart based on PAL Firmware Version 4.1.X	117
5. External Connectors for PAL and - <i>xt</i> System	121
6. Intended Use for PAL System	125
6.1. Introduction	125
6.2. Intended Use	125
6.3. Disclaimer and Restrictions on Use	125
7. PAL Accessories	126

C. List of Figures

- Figure 1. PAL Control Terminal and Conventions
- Figure 2. Accessing a Method Screen
- Figure 3. Verifying Tray with corresponding Tray Type
- Figure 4. Example of Job Queue Screen
- Figure 5. Selecting Utilities Functions
- Figure 6. Selecting Info Functions
- Figure 7. Selecting Setup Functions
- Figure 8. HTS PAL Major System Components
- Figure 9. Attachment of Mounting Claws
- Figure 10. Attaching the PAL Injection Unit
- Figure 11. Connecting the Injection Unit Ribbon Cable
- Figure 12. Inserting the Injection Unit Mounting Torx Screws
- Figure 13. HTS PAL with Injection Unit and Standalone Supports
- Figure 14. Installing the Keypad Terminal
- Figure 15. Installing the Injection Valve Drive
- Figure 16. Installing the Fast Wash Station
- Figure 17. Fast Wash Station Assembly
- Figure 18. Electrical Connection Fast Wash Station
- Figure 19. Installing a Microplate Stack with 3 or 6 Drawers
- Figure 20. Installing a Tray Holder
- Figure 21. Electrical Connections for HTS PAL System
- Figure 22. Electrical Connections for PAL HTS-*xt* System
- Figure 23. Object Reference Position
- Figure 24. Menu Screen Object Tray Holder
- Figure 25. Inclined Tray, Corrections for X-, Y-, Z-Axes
- Figure 26. Tray Holder Reference Position
- Figure 27. Stack Reference Position
- Figure 28. Demonstrating a possible Inclination of Tray in X-, Y-, Z-Axes
- Figure 29. Tray Type VT 32
- Figure 30. Tray Type DW96
- Figure 31. Utilities Function "Trays"
- Figure 32. Adjusting "Offset X,Y,Z" for Tray Position 001
- Figure 33. Adjusting Row Inclination at Second Tray Corner Position
- Figure 34. Adjusting Column Inclination at Third Tray Corner Position
- Figure 35. Wash Station Wash1/Wash2 Reference Point
- Figure 36. LC Valve and Waste Reference Position
- Figure 37. Positioning Z-Axis Needle Guide on Valve Needle Guide
- Figure 38. Syringe and Syringe Adapter for Liquid Injections
- Figure 39. Installing and Removing a Syringe for Liquid Injections
- Figure 40. Flow Path LC Injection Valve Cheminert Type
- Figure 41. Flow Path LC Injection Valve W-Type
- Figure 42. Flow Path LC Injection Valve "Rheodyne PD7991"
- Figure 43. Flow Path LC Injection Valve 'Rheodyne PD718-313'
- Figure 44. Valve Needle Guide and Valve Needle Seal
- Figure 45. Menu Screen Valve Needle Penetration Depth
- Figure 46. Needle Penetration in Valve Inlet Port
- Figure 47. COM Port Settings
- Figure 48. Reading the MAC Address
- Figure 49. PAL-*xt* Communication Settings
- Figure 50. Setting Communication Mode

List of Figures (contd.)

- Figure 51. Selecting "Setup" in Extended User Mode
- Figure 52. Selecting "Objects" in Extended User Mode
- Figure 53. Pattern Tray Type "Regular"
- Figure 54. Pattern Tray Type "Staggered+"
- Figure 55. Pattern Tray Type "Staggered-"
- Figure 56. Replacing MOTIO Board
- Figure 57. Replacing CPU Board
- Figure 58. Replacing Control-*xt* Board
- Figure 59. Replacing the Injection Valve Cheminert Type
- Figure 60. Replacing the Injection Valve W-Type
- Figure 61. Replacing the Injection Valve Rheodyne PD 7991 Type
- Figure 62. Replacing the Injection Valve Rheodyne PD719-313
- Figure 63. Rotor Replacement of Cheminert Type Valve
- Figure 64. Rotor Replacement of W-Type Valve
- Figure 65. Rheodyne Valve PD7991, Rotor Position
- Figure 66. Valve Drive Settings for Rheodyne Valve PD7991
- Figure 67. Valve Position 'Standby' and 'Active', PD718-313
- Figure 68. Actuator Position 'Standby and 'Active', PD718-313
- Figure 69. HTS PAL Firmware Overview, page 1
- Figure 70. HTS PAL Firmware Overview, page 2
- Figure 71. HTS PAL Firmware Overview, Page 3
- Figure 72. HTS PAL Firmware Overview, Page 4
- Figure 73. PAL HTS-*xt* Firmware Overview, Page 1
- Figure 74. PAL HTS-*xt* Firmware Overview, Page 2
- Figure 75. PAL HTS-*xt* Firmware Overview, Page 3
- Figure 76. PAL HTS-*xt* Firmware Overview, Page 4

D. How to Use this Manual

note

*This User Manual covers the HTS PAL and PAL HTS-*xt* Systems. Issues specific to the PAL HTS-*xt* model have been emphasized as such.*

Follow the description given in this manual to install and operate the PAL model "HTX PAL," which differs only by its X-axis length of 120 cm as compared to 80 cm for the HTS PAL model and thus is not handled separately. For the same reason, model PAL HTX-*xt* is also not handled separately.

Unless stated otherwise, this manual refers to all HTS PAL models.

The manual is divided into the following major sections:

- Safety Information
- HTS PAL Operating Instructions
- Specifications
- Product Warranty
- HTS PAL Description and Installation
- Troubleshooting
- Replacing Parts
- Maintaining PAL System
- Appendices

The "HTS PAL Operating Instructions" in section E are intended for infrequent PAL users or new users who already have experience using automated systems to perform standard analytical methods.

note

The HTS PAL must be installed and set up properly before the Operating Instructions in Section E can be used.

Users who are installing an HTS PAL system or HTS PAL accessories, or who need to adjust an installed system, should consult "HTS PAL Description and Installation" in Section F.

The Appendices provide useful information such as the Software Flow Chart, Definition of Terms, Injection Cycle parameter descriptions, or the HTS PAL accessories guide.

E. HTS PAL Operating Instructions

1. Using the Control Terminal

The following procedures present the key steps required to set up and process multiple groups of samples with the HTS PAL. They are intended to provide an overview for new users and a reminder for infrequent users. The HTS PAL and all accessories should be installed with Objects defined correctly. A syringe of the specific type called for by a particular method should also be installed.

Figure 1 illustrates the PAL control terminal and the conventions used to enter, edit, and view information.

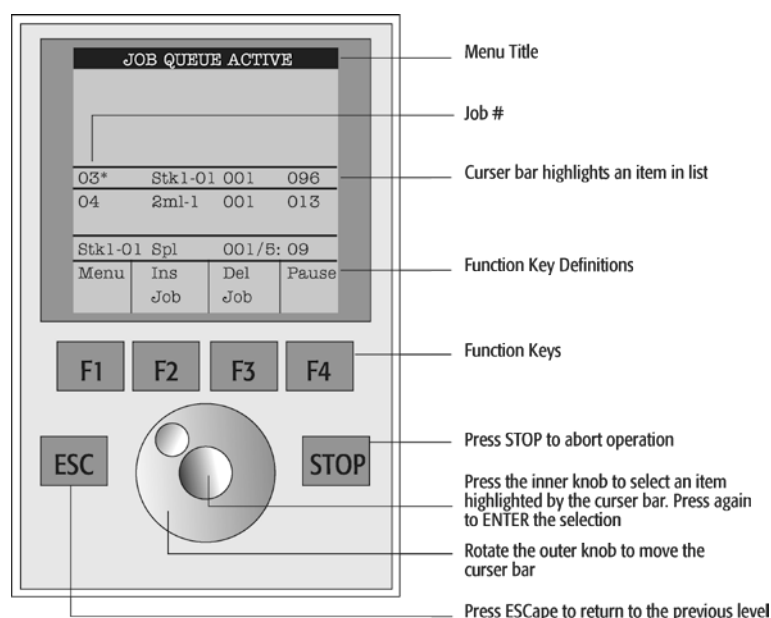


Figure 1. PAL Control Terminal and Conventions

1.1. Menu Screens

Different menu screens are displayed, depending on the HTS PAL operating status and the particular function being accessed by the operator. All menu screens have the same basic format. The menu title is displayed at the top of the screen. A list of items is displayed below the title. The date and time, or status, are shown in the highlighted area above the Function key labels on the bottom of the screen.

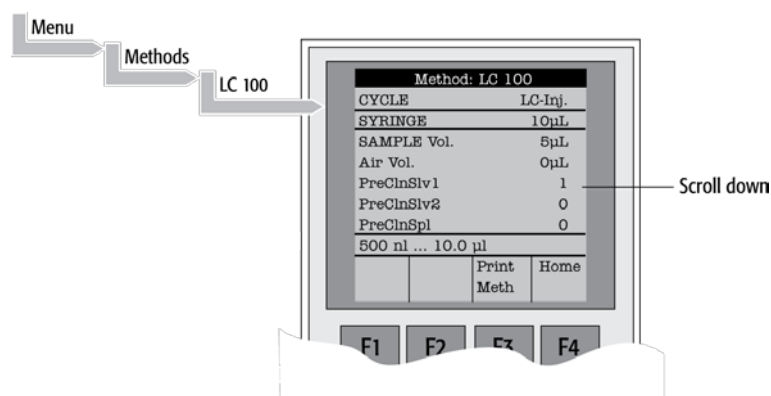


Figure 2. Accessing a Method Screen

1.2. Function Keys

Options for a particular menu are assigned to the corresponding function keys (**F1**, **F2**, **F3** and **F4**) directly below each function key label.

Pressing the function key labeled **Home** will always return to the Job Queue menu.

1.3. ESCape and STOP Keys

Press the **ESC**ape key to return to the previous menu. Press the **STOP** key to abort the current Cycle, Job, or Job Queue.

1.4. Scroll Knob and ENTER Button

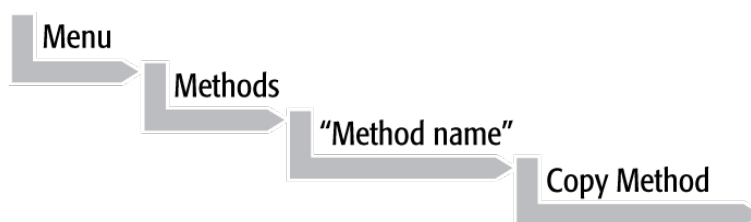
Rotate the outer knob to scroll through items in a menu list. To select a highlighted item press the central knob (**ENTER** button). Then use the outer knob to scroll through available options for that item or to change a numeric value. Then press the inner knob again to **ENTER** the displayed option. The inner knob is also used for other operations that require an **ENTER** operation to continue or complete an operation.

2. Methods

2.1. Creating Methods

Methods can be defined by the user and assigned names up to eight characters in length. **Methods** can be created, copied, edited, and viewed from the Methods menu. Methods can be viewed (but not edited) from the Job Queue menus.

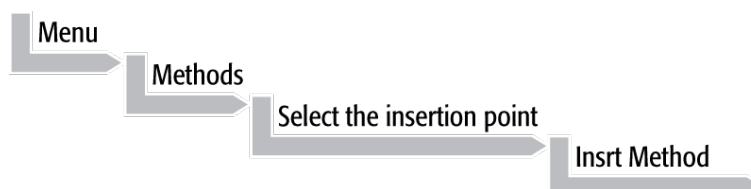
Methods are created by either copying an existing Method or creating a new Method.



To copy a **Method**, complete the sequence as follows.
You will be prompted to enter a name for the new Method.

Use the scroll knob and the left-right arrow function keys (F2 and F3) to select among alphanumeric characters and spaces. Press the ENTER function key (F4) to accept the name.

To create a new Method, complete the following steps:



1. Assign and enter a new Method name as above. After a copy of the Method has been created, the Method parameters will display and can be edited. The Cycle and Syringe entries cannot be changed;
2. If the Method is new (i.e. added), select and enter a Cycle that is appropriate for the application;
3. Select the specific Syringe to be used by the Method;

note

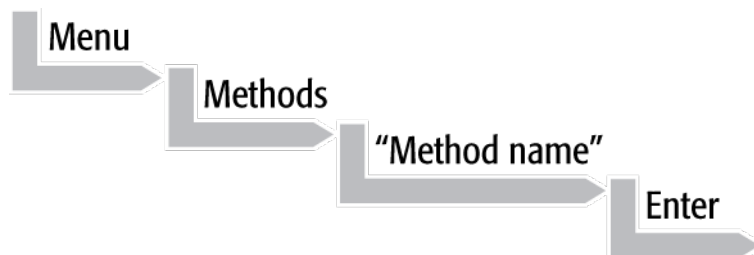
Once a Method has been created and saved, the Cycle and Syringe cannot be changed. To use a different Cycle or Syringe, a new Method must be created.

4. Assign Parameter values according to the application requirements. Consult Appendices point 3, HTS PAL "Injection Cycle Parameters" for details on specific items.

2.2. Edit / View Methods

Method parameters (excluding Cycle and Syringe) can be viewed and changed from the Method menu as follows:

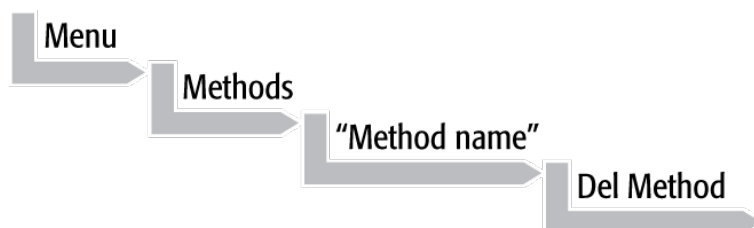
Complete the following menu selections:



1. Scroll to and select the parameter to be changed. Assign the new value and press the **ENTER** key;
2. Exit from Parameter List by pressing either the **Home** function key (F4) to return to the top-level Job Queue menu or the **ESCAPE** key to return to the previous menu;
3. Method contents may be viewed from the Job Queue displays by selecting the desired Job, pressing **ENTER**, followed by the View Method function key.

2.3. Delete Methods

Methods can be deleted from the Methods menu. Methods in use by an active Job cannot be deleted. Complete the following menu selections to delete a Method.



3. Job and Job Queue

A **Job** bundles the specified Tray with the designated vials (samples) and with the Method to run those samples. Another term often used for “Job” in the chromatographic field is “sequence”.

If more than one Job is prepared, the term **Job Queue** is used.

Before a Job can be activated the operator must verify that the Tray Type matches the specified Tray and vial size (type). This step is done in **Utilities** class.

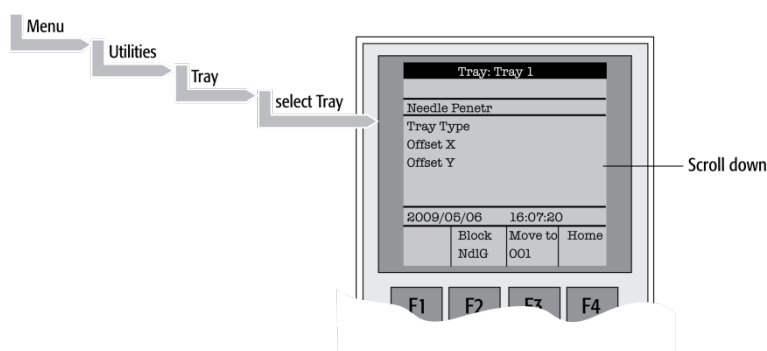


Figure 3. Verifying Tray with corresponding Tray Type

Select the corresponding Tray Type. By activating function key “F3” the injection unit can be moved to the first position and to another two corner positions to verify the correct selection of the Tray Type and teaching position.

3.1. Building and Starting a Job Queue

1. Power up the HTS PAL. The **JOB QUEUE** screen is displayed;

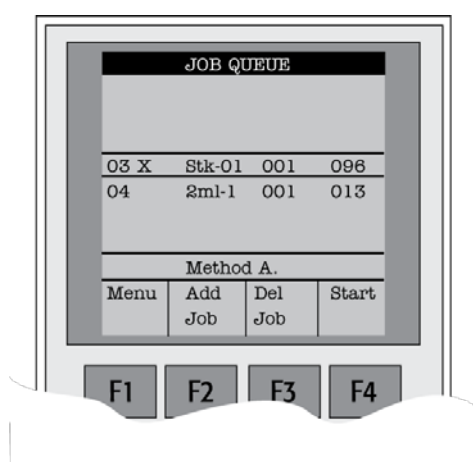


Figure 4. Example of Job Queue Screen

2. Load a sample Tray onto an available location in a Tray Holder or Stack.
Note the corresponding Tray name;
3. Add a new Job for the Tray. Press the **Add Job** key to bring up the default Job;
4. For TRAY, select the Tray name (e.g. stk1-01) that corresponds to the location of the Tray that was just loaded;
5. Enter the **First** and **Last** sample number for this Job;
6. Select and enter the sample processing **Method** for this Job;
7. Press the **Home** function key (**F4**) to return to the **JOB QUEUE** screen;
8. To add additional samples to be processed, repeat steps 2 – 7;
9. If necessary, replace and/or clean the syringe (liquid versions only).
Press the Menu key to see the available options for changing (**F1 Change Syringe**) and cleaning (**F2 Clean Syringe**). To completely remove air bubbles, the syringe should be primed manually.
(See Section F. "Description and Installation", point 5.2, "Syringe Priming".);
10. If only one Job is to be processed, select the Job with the scroll knob.
Press Start key. In the dialog box "**Select Job(s) to Process**" select one of the following options:
 - **All** (Entire Job Queue starting from the top)
 - **Selected** (Job selected with the cursor bar)
 - **Resume** (Continue with the next Job after the one aborted.).

3.2. Aborting a Job Queue

1. Press **STOP**;
2. Select one of the available options
(**Continue**, **Sample**, **Job**, or **Job Queue**);
3. Select **Continue** to resume processing with the current sample;
4. Select **Sample** if there is a problem with only the current sample.
Processing will resume with the next sample;

5. Select **Job** to abort processing all samples in the current Job. Processing will resume with the next Job. The aborted Job is marked with an **X**;
6. Select **Job Queue** to abort processing all Jobs. The JOB QUEUE screen will be displayed. The aborted Job is marked with an **X**.

3.3. Restarting an aborted Job Queue

1. Press the **START** key;
2. Select the **Resume** option. The Job after the last one marked as aborted will be started.

4. Utility Functions

Utility functions, selectable from the **Menu** screen, provide quick access to checking operations and parameters that may need to be changed. These functions are available for the actual Syringe, Trays, Injectors, and the Wash Station. They allow access to key functions without having to set up and execute a Method and Job.

note

If an item is used in the sample processing cycle, the appropriate Utility value will be overwritten by the Method value.

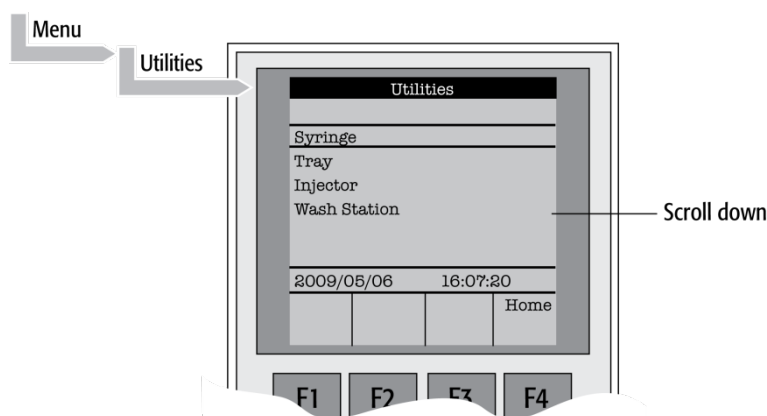


Figure 5. Selecting Utilities Functions

4.1. Syringe

The following functions are available by pressing a Function Key:

Function Key	Description
<i>F1</i> Chang Syr	The syringe is moved to a position in which the syringe assembly can be completely lowered to facilitate removal of the syringe adapter. The syringe can then be removed from the adapter and replaced. A prompt will be displayed to specify the new syringe. The syringe must be installed before pressing Enter . (See Section F. "Description and Installation", point 5 "Syringes".)
<i>F2</i> Clean Syr	This Function is used to clean or prime the syringe prior to use. After selecting F2 either Wash1 or Wash2 can be selected.
<i>F3</i> Set Pos	Set Pos is used to define the Chang Syr position.
<i>F4</i> HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

The following Syringe items may be changed by selecting the particular item:

Item	Description
Actual ID	Indicates the identification number (ID) of the currently inserted syringe. If the syringe detection system is set to manual, the message "Syringe: No syringe" is displayed.
Fill Volume	This parameter serves to control the filling of the syringe. It can occur that air bubbles remain below the plunger after the first pull up. If the plunger is moved up and down several times (see Fill Strokes), these air bubbles are worked out. With this operation the syringe can be completely filled even when using very small sample volumes.
Fill Strokes	Number of fill strokes. All fill strokes, except the last one, use the selected fill volume. If the selected sample volume is greater than the fill volume, the sample volume is used for all fill strokes. If zero is selected the plunger is pulled up only once using the sample volume value.
Pullup Del	By using this item, a delay time can be selected between sample pullup and ejection while filling the syringe. When the plunger reaches the zero position during the fill strokes, the system waits half the Pullup Del time. This allows for an air bubble to float away from the needle tip. This feature is especially useful for removing any air bubble in the syringe and handling viscous fluids.
Fill Speed	Speed of plunger movement used in all syringe filling operations.
Eject Speed	Speed of plunger movement used in all syringe eject operations except sample injection.
Inject Speed	Speed of plunger movement for sample injection. Typically used for "Fill Strokes".
Plunger Chnge Pos	Plunger position during "Change Syringe" operation. The syringe plunger is moved to a position where the syringe can be removed and replaced. The value may be changed for different types of syringes.

4.2. Tray

After selecting the particular Tray to be accessed, the following functions are available:

Function Key	Description
<i>F2</i> Block NdlG	F2 activates Needle Guide blocking. The option after activation is "Rel NdlG", releasing Needle Guide Blocking. It may be used to test the functionality of the solenoid that blocks the needle guide.
<i>F3</i> Movto nnn	This function serves as a quick check to determine if the X,Y,Z-coordinates are defined correctly for the selected Tray. To use this utility the selected Tray, including the sample vials, must be present. After pressing "Movto 001" the Injection Unit moves to sample position no.1. This procedure can be repeated for the last sample position in the first row and the last sample position.
<i>F4</i> HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

The following Tray items may be changed by selecting the particular item:

Item	Description
Needle Penetr	Needle penetration depth into the sample vial. The needle penetration depth for the selected Tray can be changed by entering the desired value.
Tray Type	The Tray Type which is selected for the Tray is shown. If the Tray enables the use of different Tray Types it can be changed at this position.
Tray Offset X	If necessary, a correction to the ideal X-position of "Position 1" can be made by using "Tray Offset X".
Tray Offset Y	If necessary, a correction to the ideal Y-position of "Position 1" can be made by using "Tray Offset Y".
Tray Offset Z	If necessary, a correction to the ideal Z-position of "Position 1" can be made by using "Tray Offset Z".
<i>dxRow</i>	Correction of any inclination of a Tray (plate) in the X-axis of a row (see Fig. 25 for details).
<i>dyRow</i>	Correction of any inclination of a Tray (plate) in the Y-axis of a row (see Fig. 25 for details).
<i>dzRow</i>	Correction of any inclination of a Tray (plate) in the Z-axis of a row (see Fig. 25 for details).
<i>dxCol</i>	Correction of any inclination of a Tray (plate) in the X-axis of a column (see Fig. 25 for details).
<i>dyCol</i>	Correction of any inclination of a Tray (plate) in the Y-axis of a column (see Fig. 25 for details).
<i>dzCol</i>	Correction of any inclination of a Tray (plate) in the Z-axis of a column (see Fig. 25 for details).

Items displayed in "italic" are available beginning with PAL Firmware version 4.1.X.

note

A "staggered pattern" is selectable in firmware class "Tray Type". For details see section F. "Description and Installation", point 10.3.1 "Tray Type".

4.3. Injector

After selecting the particular Injector to be accessed, the following functions are available:

Function Key	Description
<i>F3</i> Movto Inj	The Injection Unit moves to the selected injector position. With this function, e.g. the injectors GC-Inj1, Waste, Waste2 and Flush can be accessed. By selecting the parameter "Needle Penetr" on the same screen, the Injector Needle Penetration value can be checked or changed.
<i>F4</i> HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

The following Injector item can be changed by selecting the particular item:

Item	Description
Needle Penetr	By selecting the parameter "Needle Penetr" the Injector Needle Penetration value can be checked and/or changed. To ensure reproducible sample injections and minimize carry-over it is critical that the needle penetration depth be accurately set.

4.4. Wash Station

After selecting the specific Wash Station, the following functions are available:

Function Key	Description
<i>F3</i> Movto Wash	The injection unit moves to the selected Wash Station port. By selecting the Parameter "Needle Penetr" on the same screen the Wash Station Needle Penetration value can be checked or changed.
<i>F4</i> HOME	The injection unit moves to its HOME position and the Job Queue Menu is displayed.

Item	Description
Needle Penetr	By selecting the Parameter "Needle Penetr" the Wash Station Needle Penetration value can be checked and/or changed.
Rinse Time	If rinse time is activated (value > 0), the solenoid of a Fast or Active Wash Station opens for the specified time after the syringe needle has been removed from the wash port (after completion of the syringe wash cycle). The solvent flows into the wash port without the restriction of the needle; be aware of higher solvent consumption.

The following Wash Station items may be changed by selecting the particular item:

Item	Description
Needle Penetr	By selecting the parameter "Needle Penetr" the Wash Station needle penetration value can be checked and/or changed.
Rinse Time	If rinse time is activated (value > 0), the solenoid of a Fast or Active Wash Station opens for the specified time after the syringe needle has been removed from the wash port (after completion of the syringe wash cycle). The solvent flows into the wash port without the restriction of the needle; be aware of higher solvent consumption.

4.5. Vial

After selecting the specific Vial type*, the following functions are available:

Function Key	Description
F3 Movto Vial	The injection unit moves to the selected vial type. By selecting the parameter "Needle Penetr" on the same screen, the Wash Station Needle Penetration value can be checked or changed.
F4 HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

* Available Vial types:

- Standard: Vial in Standard Wash Station for GC (front position).
- Fiber Exp: Position to block needle guide.
Mainly used for SPME application. See SPME User Manual.

Item	Description
Needle Penetr	By selecting the parameter "Needle Penetr" the Wash Station needle penetration value can be checked and/or changed.

4.6. Dilutors

After selecting the specific Dilutor, the following functions are available:

Function Key	Description
F1 Prime	The Dilutor syringe is primed with solvent after activating the F1 function.
F2 Chang DSyr	Activating F2 moves the plunger of the Dilutor Syringe to standby position to allow easy access to change the syringe.
F4 HOME	The Injection Unit moves to its HOME position and the Job Queue Menu is displayed.

The following Dilutor items can be changed by selecting the particular item:

Item	Description
Syringe	Indicates the Dilutor side-port syringe inserted in the Z-axis. This function allows selecting another syringe size.
Syr Dilut Pos	Activating this function moves the plunger of the side port syringe up by the specified distance. This allows adjustment of the plunger tip of the side port syringe exactly above the lower side port (solvent inlet). This fine tuning is necessary after changing a side port syringe to allow unrestricted solvent flow.
Dilutor Syr	Indicates Dilutor Syringe is installed. If the syringe size is changed, this item must be adapted accordingly. The syringe-specific dimensions are coordinated by this function.
Prime Volume	A volume to prime the Dilutor Syringe can be specified. The allowed range can be fourfold higher than the actual syringe volume. This allows filling and emptying a dilutor syringe more often than just once.
Pullup Delay	Using this item permits selecting a delay time between solvent filling and ejection while filling (or priming) the syringe.
Fill Speed	Speed of plunger movement of Dilutor Syringe used in all syringe filling operations.
Eject Speed	Speed of Dilutor Syringe plunger movement used in all dilutor syringe eject operations.
Eject Delay	Using this item permits selecting a delay time between solvent ejection and filling while filling (or priming) the syringe.

4.7. Tools

note

The Object class "Tools" is available with PAL Firmware version 3.0.X, 4.1.X. or higher.

After selecting the specific tool, the following functions become available:

Function Key	Description
F1 Chk Offs	The item "Check Offset" can be used to verify the offset from the syringe needle tip to the tool tip. This item is mainly used for the MALDI tool; it is not active for the MHE tool.
F4 HOME	The injection unit moves to its HOME position and the Job Queue Menu is displayed.

The following tool items may be changed by selecting the particular item:

Item	Description
Teach Point	The reference point at which to teach the Object (Tool; MHETool) is selectable. In the case of the MHETool, no extra position is necessary. The Parking Station is the fix point. Select "None."
ToolOffset X	If necessary, a correction to the ideal X-position of the MHETool can be made by using "ToolOffsetX".
ToolOffset Y	If necessary, a correction to the ideal Y-position of the MHETool can be made by using "ToolOffsetY"
ToolOffset Z	If necessary, a correction to the ideal Z-position of the MHETool can be made by using "ToolOffsetZ" A "ToolOffsetZ" of -48.0 mm is necessary to position the MHETool on the sample vial.

5. Logfile

The PAL logfile cannot be read-out directly on the terminal display. However, the function key "F3" does allow a print out. A serial printer has to be connected to port "SER2" for the PAL System and to the port "SER1" for PAL-xt System. If a serial printer is not available use a serial/parallel converter.

6. Info Functions

Info functions, selectable from the Menu screen, provide quick access to information to be viewed. These info functions are available for the Hardware, Software Maintenance, Free Objects, and Free Items.

All items with the exception of "Maintenance" are read only.

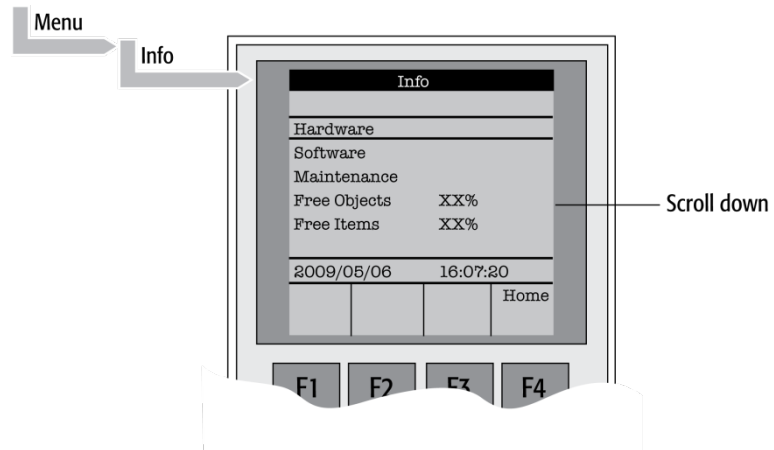


Figure 6. Selecting Info Functions

6.1. Hardware

Item	Description
CPU SNo	The serial number (SNo.) of the PCB "APR CPU" is displayed.
CPU ID	Version number of the PCB "APR CPU".
MOTIO ID	Version number of the PCB "APR CPU".

6.2. Software

Item	Description
PAL Firmware	Firmware version of PAL System.
Head Firmware	Firmware version of PAL Injection Unit.
Terminal FW	Firmware version of PAL Terminal.
Altera Firmware	Firmware version of the Altera component.

6.3. Maintenance

Item	Description
PlgStrokeCnt	This is a counter for syringe plunger movements. The actual number of strokes is displayed. If the counter reaches the set limit (PlgStrkeLim) a warning is displayed at the next start of a job (run). The system continues but signals the user to verify syringe conditions. The counter can be set back to zero to restart. There is only one counter for a syringe. If syringe types are changed the system continues to count as if it were the same type.
PlgStrokeLim	An upper limit for the syringe plunger strokes can be set.
Inject Count	This counter monitors the number of injections. The number of injection valve switches is a helpful tool for the user to decide on a replacement of parts of the injector system. The actual number of injections (valve switches) is displayed. If the counter reaches the set limit (Inject Limit), a warning is displayed at the next start of a job (run) (Inject Limit). The same counter is used for injector penetrations with GC technique.
Inject Limit	An upper limit for the number of injections can be set.

note

Counters for the plunger movement and injector penetrations are available with PAL Firmware version 2.5.X or higher.

6.4. Free Objects / Free Items

In addition to the core software, the PAL Firmware contains data for the "Firmware Objects". There are different classes of Objects, such as Syringes, Trays, Tray Holders, etc. Each class of Objects contains "Items". The items contain the actual data such as X-, Y-, Z-positions. The data are stored in a flash memory backed up by a battery. To optimize RAM and Flash memory use, a certain section of memory has been reserved by the software for each of the Objects and Object Items. The percentage shown in the "Info" section provides an indication as to how much of the reserved software space is still available.

7. Setup Functions

The **Setup** functions, selectable from the Menu screen, allow access to various functions for the PAL System. The "Sound", "Time" and "Objects" are basic functions used at installation or if changes have been made over time.

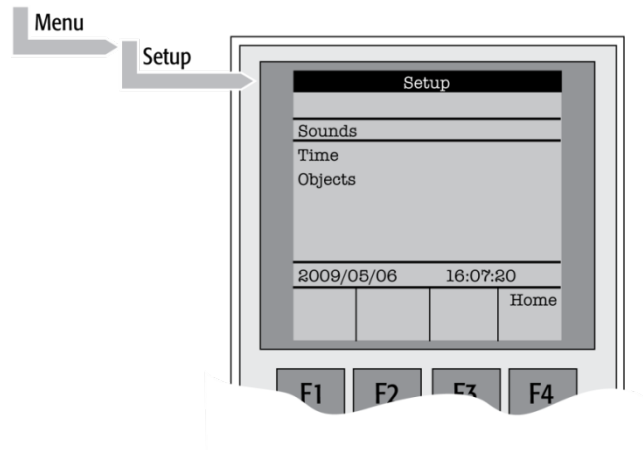


Figure 7. Selecting Setup Functions

7.1. Sounds

Item	Description
Message Box	A specific dual beep tone signals that a pop-up window (Message Box) for user intervention appears on the screen. This beep signal can be turned on or off.
Warn Move	A beep sound is heard at the start of the PAL movement. It is advisable to keep this function turned on for safety reasons.
End Cycle	A beep sound is heard at the end of a cycle. Select as desired.
End Job	A beep sound is heard at the end of a cycle. Select as desired.

7.2. Time

Item	Description
Year	The "year" can be set for the PAL internal clock.
Month	The "month" can be set for the PAL internal clock.
Day of Month	The "day" can be set for the PAL internal clock.
Hours	The "hours" can be set for the PAL internal clock.
Minutes	The "minutes" can be set for the PAL internal clock.
Seconds	The "seconds" can be set for the PAL internal clock.

After setting or resetting the date and time, use the function key "F1" "Set Time" to store.

7.3. Objects

The various PAL Firmware Object classes can be selected and the functions most used by the user are directly accessible. For detailed listing see PAL Firmware overview in the appendices.

F. HTS PAL Description and Installation

1. General System Overview

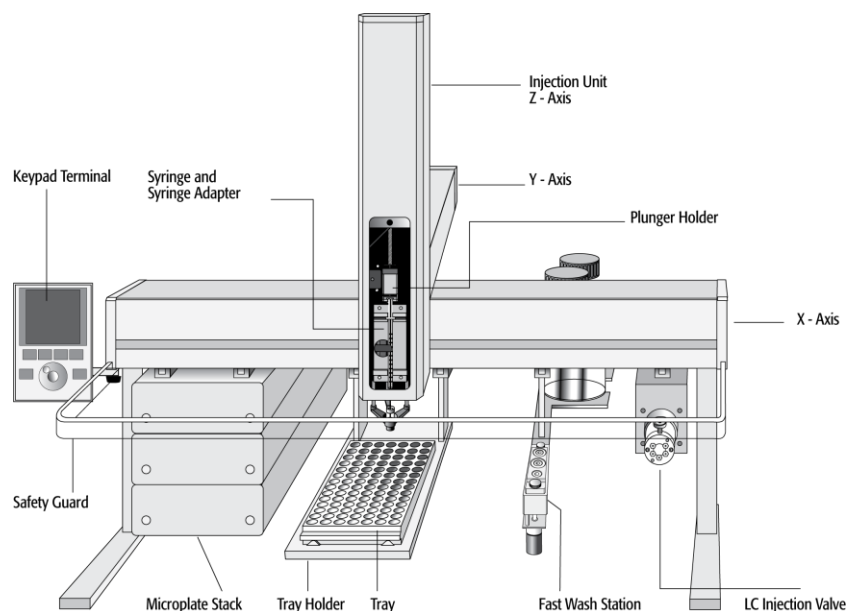


Figure 8. HTS PAL Major System Components

The standard HTS PAL includes the following hardware:

- 1 X-, Y-axes assembly;
- 1 Injection Unit, Z-axis;
- 1 Syringe kit for liquid injections;
- 1 Fast Wash Station for two different solvents;
- 1 Keypad terminal;
- 1 Safety Guard;
- 1 Standard standalone supports, 215 mm.

Optional TraySets (Tray Holder and Tray) and/or Stacks of various types and in different variations are required and can be added.

1.1. Specifications

1.1.1. Sample Capacity

- 98 x 2 mL vials per Tray
- 200 x 1 mL vials per Tray
- 32 x 10 mL / 20 mL vials per Tray
(up to three Trays can be configured)
- 108 x 2 mL vials per Stack Cooler 2 DW (2 x 54 vials 2 mL)
- 216 x 2 mL vials per Stack 4 DW (without cooling/heating)
- 2 Micro- Deepwell plates per Stack Cooler 2 DW
- 4 Micro- Deepwell plates per Stack 4 DW
- 6 Deepwell- or microtiter plates in Stack or Stack Cooler 6DW,
or 6 x 54 vials 2 mL
- 12 Microtiter plates in a Stack or Stack Cooler 12MT

1.1.2. Thermostatted Sample Tray

- Tray Cooler, 4 °C – 70 °C
- Stack Cooler 2 DW, 4 °C – 40 °C

1.1.3. Syringe Sizes

- 10, 25, 50, 100, 250, 500, 1000, 2500, 5000 µL

1.1.4. Liquid Injection Range

- 10 µL – 100 µL with standard 100 µL syringe
- Down to 0.1 µL with solvent sandwich technique
- Down to 0.5 µL with optional 4-port internal loop valve
- Up to 5000 µL with optional larger syringe and loop

1.1.5. Replicate Injections

- 1 – 99 from one vial

1.1.6. Minimum Sample Volume

- 1 µL from a 3 µL sample in 1 mL tapered micro vial
in liquid injection mode

1.1.7. LC Injector

- Electrically actuated fast switching Valve Drive,
6-port Injection Valve, VICI/Valco Cheminert, C2V-1006-CTC
(standard valve, other valves available on request)

1.1.8. Wash Station

- Fast Wash Station with two different wash solvents
- Other types of Wash Stations are optionally available.

1.1.9. Standard Configuration

- Syringe Volume 100 µL
- Loop size 20 µL

1.2. Performance Specification

The performance specifications are available as part of a specific, separate document.

1.3. Electrical Specifications

Parameter	Requirement
Protection class ^a	Class I
Over voltage category ^b	Category II
Pollution degree ^c	2
Moisture protection ^d	Normal (IPX0)
Voltage	36 VDC
Current	3.2 A
Fuse	T6.3 A/250 V
PAL System Power Supply	
Input line voltage	Grounded AC, 100 to 240 V
Input line frequency	50/60 Hz
Input power	4 A
Output voltage	36 VDC
Output current	4.16 A

a: Protection Class I:

Protection class describes the insulating scheme used in the instrument to protect the user from electrical shock. Class I identifies a single level of insulation between live parts (wires) and exposed conductive parts (metal panels), in which the exposed conductive parts are connected to a grounding system. In turn this grounding system is connected to the third pin (ground pin) on the electrical power plug.

b: Over Voltage Category II:

Over Voltage category II pertains to instruments that receive their electrical power from a local level such as an electrical wall outlet.

c: Pollution Degree 2:

This is a measure of pollution on electrical circuits that may produce a reduction of the dielectric strength or surface resistivity.

Degree 2 refers to normally only non-conductive pollution.

Occasionally, however, a temporary conductivity caused by condensation must be expected.

d: Moisture Protection:

Normal (IPX0) – IPX0 means that there is NO Ingress Protection against any type of dripping or sprayed water. The X is a place holder to identify protection against dust if applicable.

1.4. Physical Specifications

Parameter	Requirements
HTS PAL Systems	
Height	648 mm (25.5 in)
Depth	385 mm (15.2 in)
Width	828 mm (32.6 in)
Weight	10 kg (22 lbs.) without accessories

1.5. Operating and Environmental Requirements

Parameter	Requirements
Operating temperature range	4 to 40 °C (39 to 104 °F)
Maximum relative humidity	75%, non-condensing
Bench space	At least 24 cm (10 in.) at the rear. Access to power switch(es) and power cord(s). Clean, level and smooth surface. Solid bench plate.
Vibration	Negligible
Static electricity	Negligible

1.6. Sound Pressure Level

Parameter	Requirements
Sound Pressure Level	Measured value: 62 dBA (PAL System used for measurement) One meter from the equipment in the direction of maximum sound pressure level. According to UL 610107A-1, 1 st edition, clause 12.5. Limit < 85 dBA dBA = "A weighted" sound pressure level

1.7. Hardware and Software Requirements

1.7.1. Hardware Requirements

In order to operate a PAL System, the electronic control board must be compatible with the corresponding PAL System.

- PAL System operated with PAL Firmware version 2.X.X. or 3.0.X: either the combination of 'APR CPU' and 'APR MOTIO' or the 'APR Control' boards can be used.
- PAL-*xt* systems operating with PAL Firmware version 4.1.X or higher: 'APR Control-*xt*' board must be installed.

A PAL System can be upgraded to a PAL-*xt* System; for details contact your CTC Analytics representative.

For specific PAL hardware Modules, a minimum PAL Firmware version is required. For example, a PAL Dilutor Option requires the PAL Firmware version 2.3.X or higher, and a PAL DLW Option requires the PAL Firmware version 4.1.X or higher. Details are given either in the corresponding 'Addendum to PAL User Manual' or in the 'Addendum to PAL User Manual for PAL Object Manager Software'.

1.7.2. Software Requirements

The various PAL Software programs, such as PAL Loader or PAL Object Manager, are operated with Microsoft Windows Operating systems, such as Windows XP and Vista. For details, see the corresponding 'Addendum to the PAL User Manual'.

The PAL System can be controlled using PAL control software, the Cycle Composer, or any data system software that controls the PAL using the Cycle Editor for PAL ICC interpretation (e.g. Analyst, ChemStation, Empower, EZChrom, MassLynx, Xcalibur).

For details on software requirements for integration of the PAL System with other data handling systems (CDS), contact your CTC Analytics representative or the manufacturer's representative of the other CDS software program.

1.8. Regulatory Compliance Requirements

As of the date of publication, this product is compliant with current RoHS and WEEE regulations.

- Directive 2002/95/EC, RoHS
- Directive 2002/96/EC, WEEE

note

CTC Analytics AG reserves the right to make improvements and/or changes to the product specifications without notice.

2. Product Warranty

2.1. Statement of Limited Product Warranty

What does this Warranty cover?

CTC Analytics AG warrants only that its products comply with CTC Analytics AG specifications.

This warranty covers defects in or failures of the Autosampler and major accessories, such as Agitator, Stack Coolers, or Valve Drives, occurring as a result of normal use or manufacturing defect.

What is NOT covered by this warranty?

This warranty does not cover defects or failures resulting from damage caused by accident, misuse or abuse, such as:

- Improper or unauthorized service or repair.
- Failure to follow the operating instructions provided by CTC Analytics AG.
- Improper or insufficient ventilation.
- *Force Majeure*: No liability for events beyond its reasonable control, including, but not limited to, fire, storm, flood, earthquake, explosions, riots, strikes, labor disputes, transportation embargoes or other contingencies beyond the control of CTC Analytics AG. (i.e. act of God" or "*Force Majeure*").
- Exposure to corrosive compounds.
- The warranty does not cover parts exposed directly to liquids, such as valves, valve rotors or other valve components, tubing or syringes or any other parts considered consumables and wear parts.

What is the Period of Coverage?

This warranty remains in effect for a period of one year from the date of installation.

What will CTC Analytics do to correct Problems?

CTC Analytics AG is represented by an authorized distributing or OEM partner in a respective country. These partners must be contacted to request technical assistance by phone to diagnose the nature and probable cause of any malfunction. If we determine that the problem is due to a defect in the instrument or a module, any replacement module(s) that has (have) been determined to be necessary to correct the problem will be sent to user's location, shipping costs at previously agreed conditions.

What will CTC Analytics NOT Do?

A service representative will not be sent to perform service at customer's location prior to a determination by the responsible CTC Analytics representative that such is necessary.

Only after telephone support and replacement of any modules sent to user's site have failed to resolve the problem will we send a service representative on site. CTC Analytics AG will not replace "consumable" parts, as explained above.

How can you get Technical Assistance?

To obtain technical assistance, call the responsible CTC Analytics representative from whom the instrument was originally purchased.

Please be prepared to provide the serial number of the instrument and discuss the problem in detail, and be willing to perform recommended tests and adjustments to help us determine the probable cause of and solution to the problem.

What must you do to keep the Warranty in Effect?

To keep this warranty in effect, the user must take care to avoid accidents, misuse and abuse, as described above under "What is Not covered by this Warranty?".

The maintenance guidelines outlined in the PAL User Manual must be followed. Preventative Maintenance (PM) or any service or repair task on the instrument must be carried out by CTC Analytics authorized personnel only.

Normal Responsibilities of the Buyer

The user must report any problem with the equipment to the responsible representative of CTC Analytics AG and assist the technical support representative in diagnosing and attempting to resolve the malfunction of the instrument. It is expected that the user will cooperate and will install any replacement parts (modules) that have been sent and will return any exchanges or unused replacement parts to the responsible representative of CTC Analytics AG at previously agreed conditions.

How does the LAW of various Countries or States relate to this Warranty?

This warranty gives you specific legal rights, and you may also have other rights which vary from country to country or from state to state.

How does this Warranty relate to Warranty Statements of various Distributing or OEM Partners?

This warranty statement from CTC Analytics AG gives the user specific legal rights. If the warranty statement from your purchaser, distributor, or OEM is broader, the added value of that warranty will be valid for the user. This, however, is not the responsibility of CTC Analytics AG, but solely that of the particular distributor or OEM partner.

3. Installation

3.1. Unpacking the Components

A HTS PAL system is shipped in one box. The box contains the X,Y-axes assembly, the Injection Unit, the Keypad Terminal, standalone Supports, connecting cables, Power Supply, Syringe kit, Wash Station assembly, Safety Guard and miscellaneous parts.

All optional parts, such as TraySet, Stack Cooler, second valve drive assembly, etc., are shipped in a separate box.

1. Open the box and first remove the accessory boxes and the Injection Unit before attempting to remove the X-, Y-axes assembly.
2. Carefully lift the X,Y-axes assembly and remove it from the box. Hold the Y-axis in place while the assembly is being removed from the box. Set the X,Y-axes assembly on a bench.
3. Unpack the remaining small boxes and any other accessories.
4. When placing the HTS PAL onto a stable surface, make sure that no objects interfere with either the Y-axis or the Injection Unit throughout the entire range of potential movement.

3.2 Assembling the HTS PAL

Before beginning the assembly process, determine approximately where the LC injection valve and keypad terminal will be located. The terminal may be mounted on either side of the X-axis.

1. If a Stack (a Tray Holder with multiple drawers) was shipped with the HTS PAL, loosen the Torx screws on the two mounting clamps located on top of the stack;
2. Move the X/Y-Carriage to the center of the X-axis and temporarily place the X-axis assembly on top of the Stack with the mounting clamp teeth fitting into the grooves on the bottom of the X-axis;

note

For HTS PALs without a Stack, support the X/Y-Carriage in a suitable manner (a sturdy cardboard box can be used) before attempting to install the legs.

3. Install the legs near the ends of the X-axis. Loosen the Torx screws on the mounting clamps and then fit one leg into the grooves in the X-axis. Be sure that the clamps fit completely into the grooves. Tighten the Torx screws until the legs are firmly in place;
4. Double check whether the leg claws are correctly attached to the X-axis (see Fig. 9).

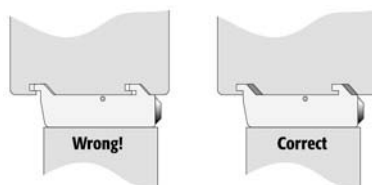


Figure 9. Attachment of Mounting Claws

3.2.1. Installing the Injection Unit

note

Installation of the Injection Unit should be done carefully. When installing it for the first time, have someone hold it in place while the mounting screws are inserted.

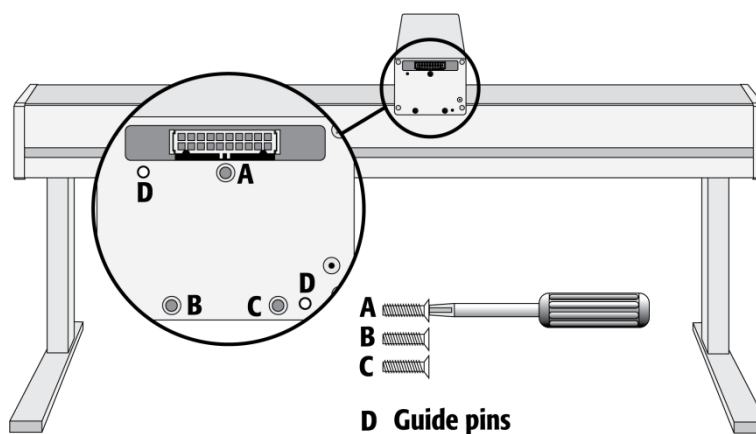


Figure 10. Attaching the PAL Injection Unit

1. Remove the three Torx mounting screws **A**, **B**, and **C**, used to fix the Injection Unit to the Y-axis;
2. Connect the ribbon cable **A** protruding from the front end of the Y-axis to the corresponding connector on the Injection Unit (see Fig. 11);

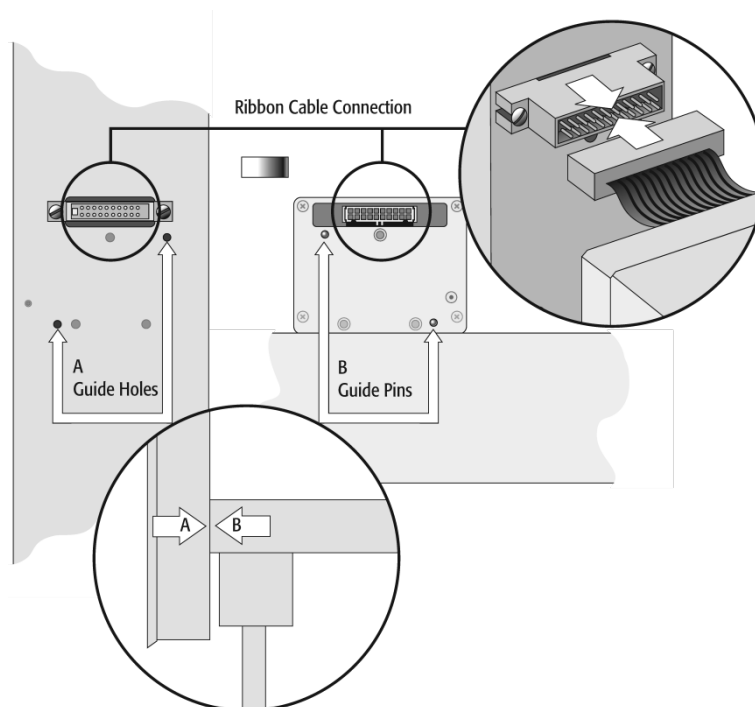


Figure 11. Connecting the Injection Unit Ribbon Cable

3. Hold the Injection Unit in place against the Y-axis. Make sure the two locating pins on the Y-axis fit into the two guide pin holes on the Injection Unit;
4. Place one of the screws onto the end of the supplied Torx driver. Slide the clear plastic cover on the Injection Unit all the way to the top. Locate the three large holes in the black anodized frame attached to the Z-axis inside the Injection Unit. Slide the frame upwards until the top hole is centered on the top threaded hole at the end of the Y-axis. Insert and securely tighten the Torx screw A (see Fig. 12);

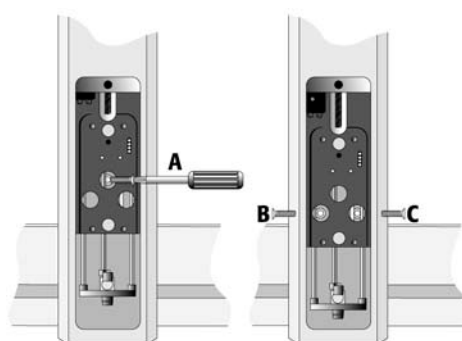


Figure 12. Inserting the Injection Unit Mounting Torx Screws

5. Install the two remaining Torx screws **B**, **C** in the left and right mounting holes, respectively. It may be necessary to move the elastic cord slightly to the left to insert the Torx screw **C** into the right-hand hole.

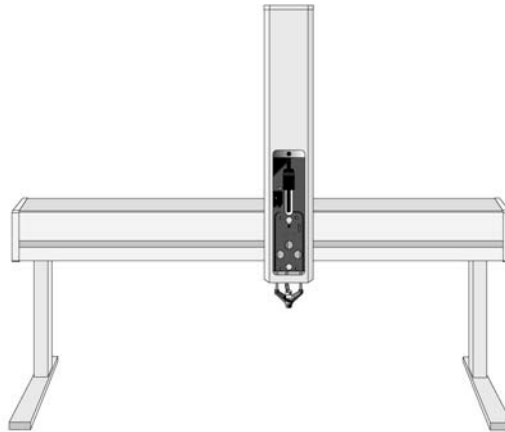


Figure 13. HTS PAL with Injection Unit and Standalone Supports

3.2.2. Installing the Keypad Terminal

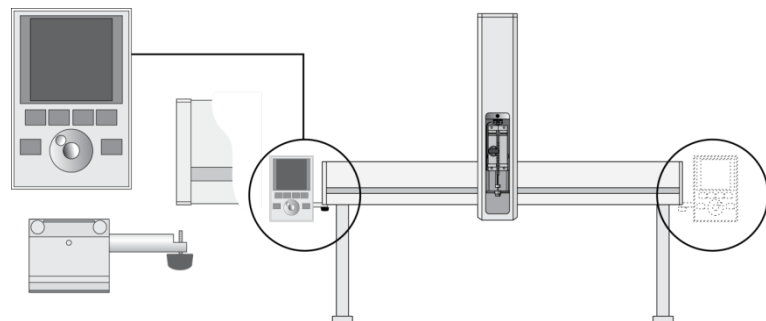


Figure 14. Installing the Keypad Terminal

1. Install the safety shield on the left and right sides to the outside of the X-axis. Use the provided, longer thumbscrew on the side where you plan to install the keypad;
2. Install the Keypad mounting bracket on either the right or left side of the X-axis;
3. Connect one end of the white coiled cable (Part No. SS8J-700) to the Keypad and the other end to the **TERMINAL (SER3)** interface jack on the rear side of the X-axis. For details see Figures 19 or 20;

note

Do not interchange the Terminal with LAN cable connector.

4. Place the Keypad terminal onto its mounting bracket.

3.2.3. Installing the Power Supply

1. Locate the power supply, the DC power cable (Part No. RS3M-2000), and the AC power cable;
2. Set the power supply switch to the OFF position;
3. Connect one end of the DC power cable to the power supply and the other end to the POWER connector at the rear side of the X-axis;
4. Connect the female end of the AC power cable to the power supply. Then connect the male end to an AC power outlet.

3.2.4. Installing the LC Injection Valve

1. Locate the blue valve drive. It will have one clamp that is identical to other Object clamps (see Fig. 15). Loosen the clamp as described above;

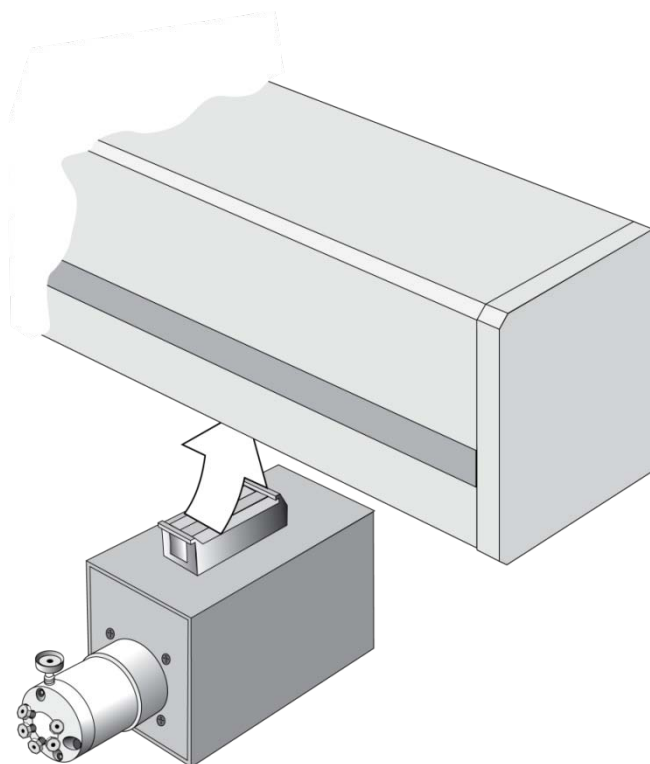


Figure 15. Installing the Injection Valve Drive

2. Attach the valve drive to the X-axis and tighten the mounting screw;

note

To avoid delay volume between sample injection point and detection, the injection valve should be located near the detection device.

3. Connect the control cable from the valve drive to AUX1;

note

The installation of another type or multiple Valve Drive(-s) is described in the Addendum to PAL User Manual "Valve Drives and Valves".

4. The injection valve and rotor are pre-installed on the valve drive.

3.2.5. Installing the Fast Wash Station

1. Attach the Wash Station assembly to the Solvent bottle holder;

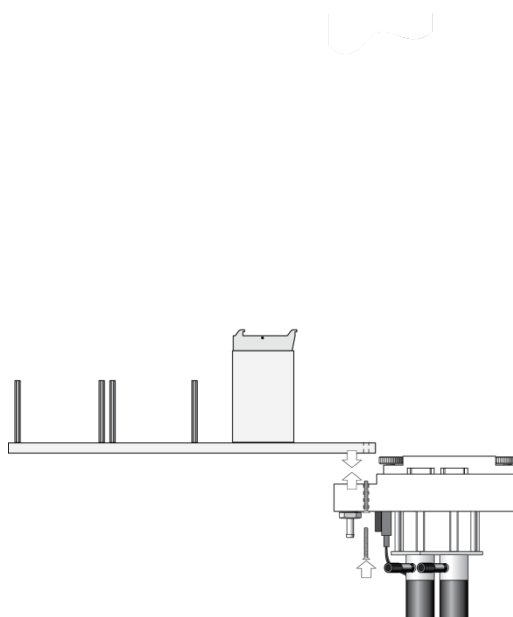


Figure 16. Installing the Fast Wash Station

2. Loosen the screw on the Fast Wash Station mounting clamp;
3. Attach the Fast Wash Station to the X-axis as close as possible to the Injection Valve. This will minimize the time required to move between the two positions;
4. Tighten the mounting screw;

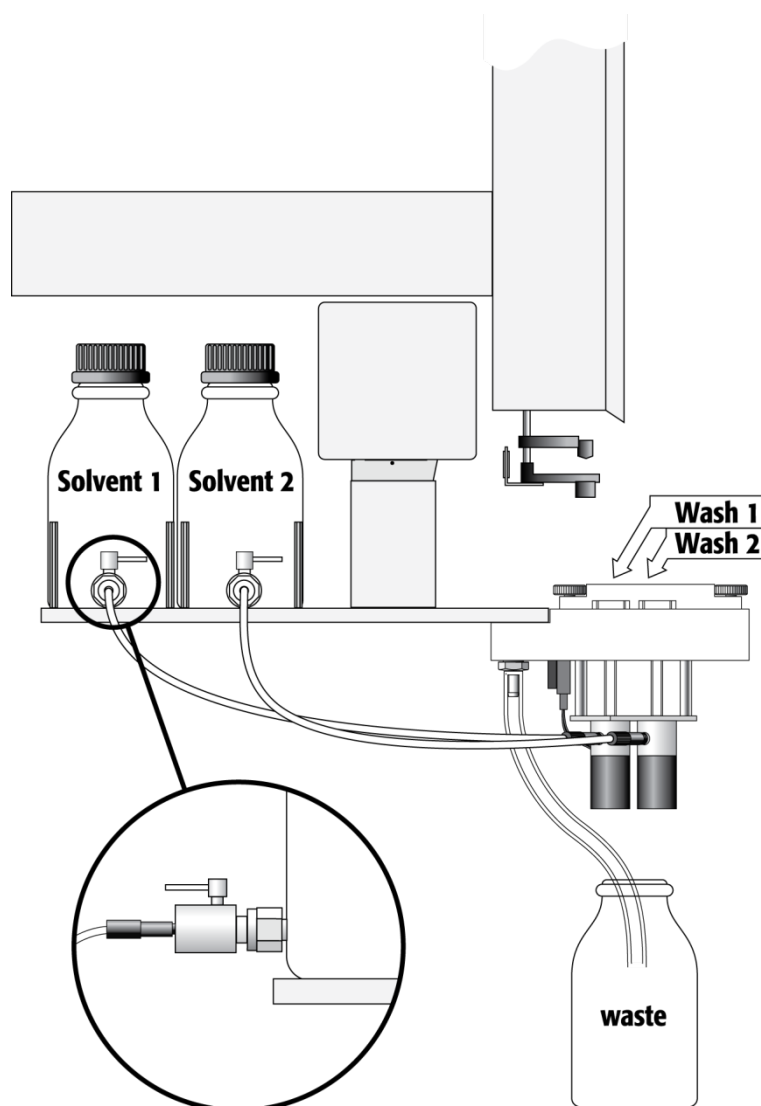


Figure 17. Fast Wash Station Assembly

5. Locate the white Teflon fittings and two lengths of PFA tubing that connect the Wash Station valves to the wash solvent reservoirs;
6. Place the reservoirs onto their holders and attach the tubing and fittings;
7. Attach one end of the supplied polyethylene tubing to the Wash Station Waste port. Place the other end of tubing into a waste reservoir (not supplied), which is positioned lower than the Wash Station assembly. Stretch the PE tubing to make sure that no used wash solvent is trapped before the Waste Reservoir;

note

The waste reservoir MUST be placed in a lower position than the Wash Station assembly.

8. Connect the control cable between PAL connector "INTERFACE 2" and the four-pronged connector located on the Fast Wash Station assembly. See below Figure 18 and for more details Figures 21/22.

note

For a PAL HTS-xt, the cable can be connected either to the INTERFACE 2 connector or to the small round connector, labeled "Wash Station". Both connectors provide the same functionality. The cable determines the connector.

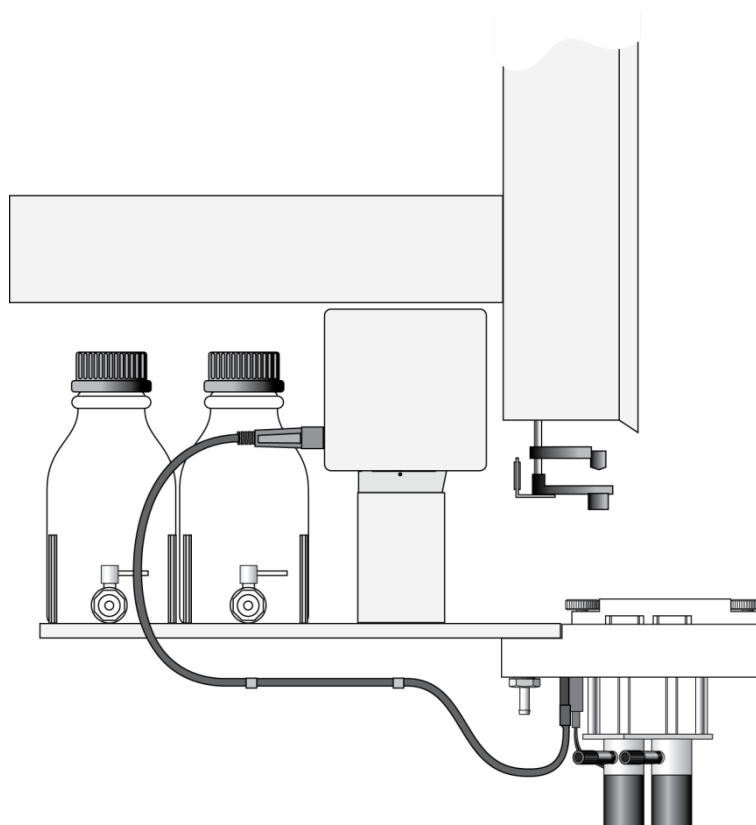


Figure 18. Electrical Connection, Fast Wash Station

note

If other types of Wash Stations are installed, such as Active Wash Station, follow the instructions in the specific Addendum of the PAL User Manual.

3.2.6. Installing a Microplate Stack

1. If a Stack (a Tray Holder with multiple drawers) was shipped with the HTS PAL, loosen the two Torx screws on the two mounting clamps located on top of the Stack. The example below shows the two stack models with 3 and 6 drawers;

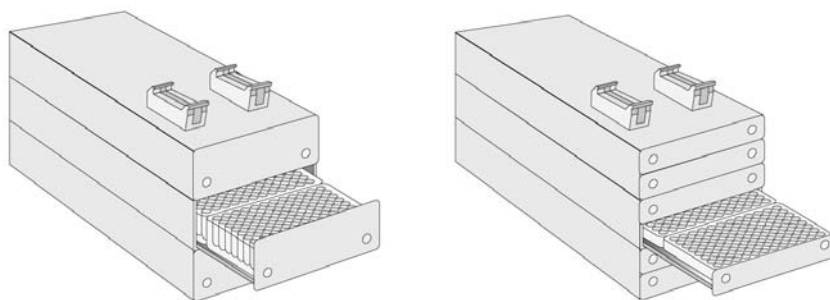


Figure 19. Installing a Microplate Stack with 3 or 6 Drawers

note

Installation of Stack and Tray Cooler is described in detail in the Addendum to the PAL User Manual "Stack and Tray Coolers".

2. Carefully lift the X-axis assembly on top of the Stack with the mounting clamp teeth fitting into the grooves on the bottom of the X-axis;
3. Be sure that the clamps fit completely into the grooves. Alternately tighten the two Torx screws until the two mounting clamps are firmly in place;
4. Double check whether the Stack clamps are correctly attached to the X-axis (see Fig. 9).

3.2.5. Installing a Tray Holder

1. If a Tray Holder was shipped with the HTS PAL, loosen the two Torx screws on the two mounting clamps located on top of the Tray Holder legs;

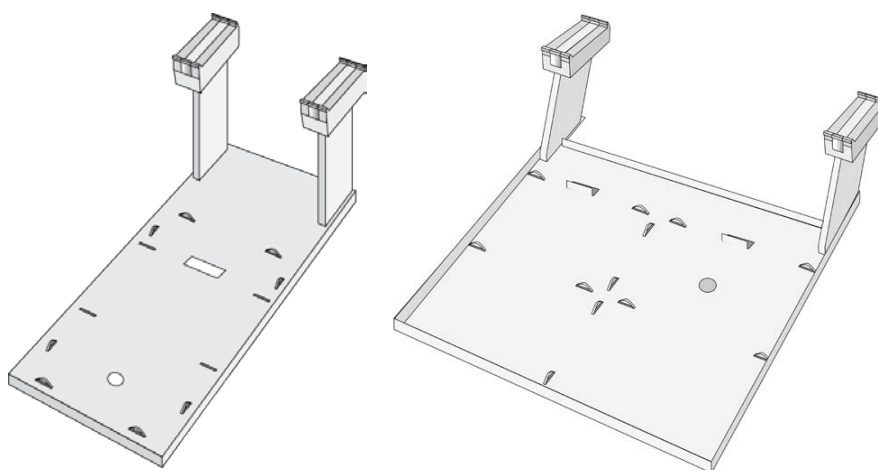


Figure 20. Installing a Tray Holder

2. Install the Tray Holder with the mounting clamp teeth fitting into the grooves on the bottom of the X-axis;
3. Be sure that the clamps fit completely into the grooves. Alternately tighten the two Torx screws until the two mounting clamps are firmly in place;
4. Double check whether the two Tray Holder clamps are correctly attached to the X-axis (see Fig. 9).

3.3. Electrical Connections

note

Always switch OFF the PAL power supply before connecting or disconnecting any HTS PAL accessories cable! Do not interchange the Terminal with LAN cable connector.

Before defining the HTS PAL Object positions, make sure the LC Injection Valve, Fast Wash Station and Keypad Terminal are correctly connected to the HTS PAL X-axis rear side.(See Figs. 21 or 22.)

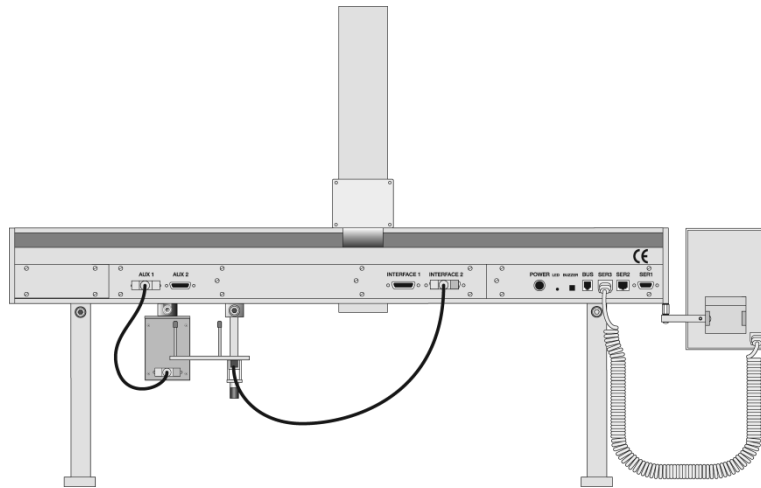


Figure 21. Electrical Connections for HTS PAL System

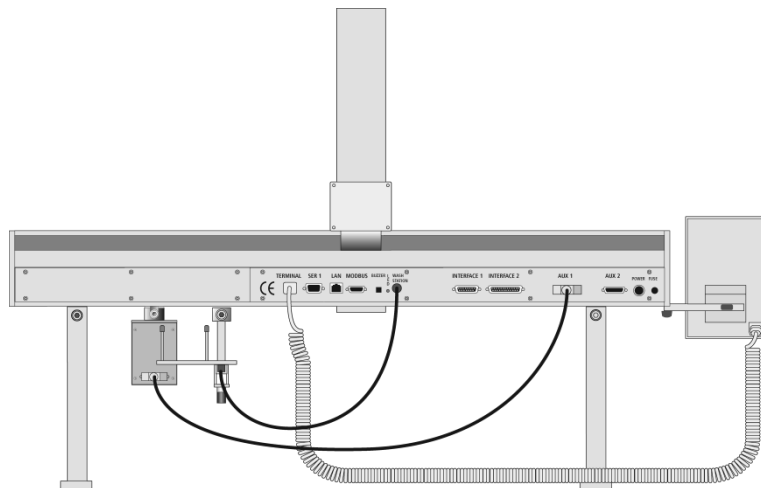


Figure 22. Electrical Connections for PAL HTS-*xt* System

note

*For a PAL HTS-*xt*, the cable from the Wash Station can be connected either to the INTERFACE 2 connector or to the small round connector, labeled "Wash Station". Both connectors provide the same functionality. The cable determines the connector.*

4. HTS PAL Object Positions

4.1. Defining Object Positions

note

Remove the Syringe Adapter from the Injection Unit before performing the following steps.

The objective is to define the Reference Positions for all HTS PAL Objects. Make sure the Tray Holder(s), Valve Drive(-s) and Wash Station are properly mounted to the PAL X-axis. The following description is an example of how to teach the reference position for a Tray Holder. The described procedure is **common** to all HTS PAL Objects.

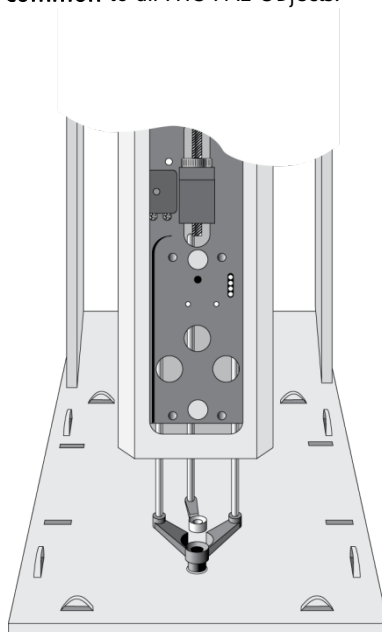
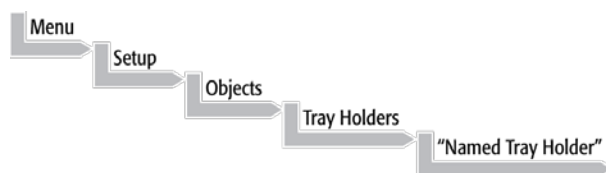


Figure 23. Object Reference Position

For a Tray Holder, the **Reference Position** is a hole (slightly larger than the lower needle guide) in the base plate of the holder. The lower needle guide should be centered in the hole with the bottom of the needle guide flush with the bottom of the base plate (see Fig. 23).

1. Switch ON the PAL power supply;
2. Observe the keypad display. The model name HTS PAL will display along with the software version number. The Job Queue menu screen will then display;

3. When the "Job Queue" menu displays, complete the following sequence (common to all objects):



where "Named Tray Holder" represents a predefined Tray Holder, (e.g. THldr1 or Stack1).

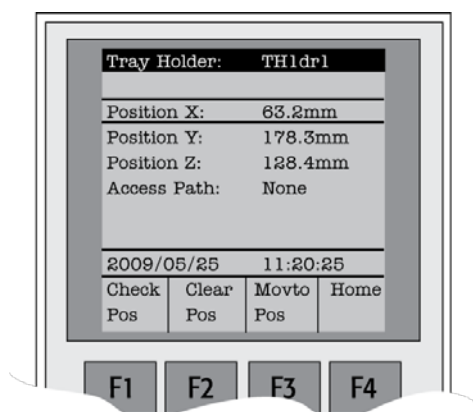


Figure 24. Menu Screen Object Tray Holder

4. After selecting "Named Tray Holder", the X-, Y-, Z- positions associated with the object will be displayed (see Fig. 24);
5. Highlight item **Position X** with the cursor bar and press **ENTER**. The Injection Unit will move to the previously defined X-axis position;
6. Rotate the outer knob to adjust the X-axis position to the Tray Holder reference position;
7. Press the inner knob to **ENTER** the **Position X** value;
8. Repeat steps 5 – 7 for **Position Y** and **Position Z**;
9. If the F3 button "**Moveto Zero**" is activated, the Injection Unit will move to the **HOME** position;
10. Verify the defined X-, Y-, Z-positions by pressing F1 "**Check Pos**".

note

PAL Firmware version 3.0.X permits correcting for an inclined surface, for example a Tray Holder or Tray where the Z-axis position in front differs from the rear position. For applications such as the PAL MALDI Option, perfect alignment of the MALDI tip is vital. This compensation for the Z-axis position is provided in the firmware class "Tool".

The release of PAL Firmware version 4.1.X makes possible the correction of all three axes, X-, Y-, Z, in the firmware class "Tray." The correction of the inclination can be made for a tilted Tray in the direction of the row and/or the column. Teaching is possible in the "Utilities" section by using the path:

Menu/Utilities/ Trays.

Figure 25 illustrates possibilities of correction. Details for teaching are given below.

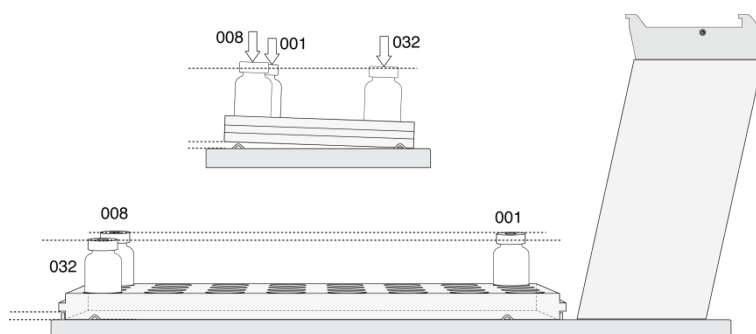


Figure 25. Inclined Tray, Corrections for X-, Y-, Z-Axes

Note that these functions are not available for the HTS PAL if operated solely on PAL Firmware version 2.4.X or higher, but neither with firmware version 3.X.X. nor with version 4.X.X.

4.2. Description of Object Positions

4.2.1. Tray Holder (e.g. THldr1)

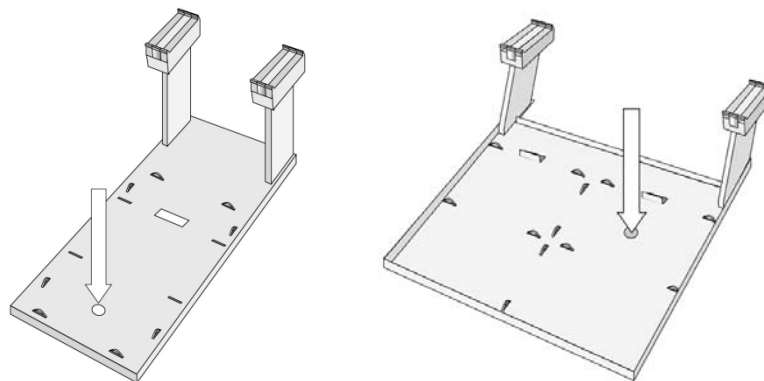


Figure 26. Tray Holder Reference Position

For a Tray Holder, the **Reference Position** is a hole in the base plate of the Holder. The lower needle guide should be centered in the hole with the bottom of the needle guide flush with the bottom of the base plate.

Figure 26 shows the example of a Tray Holder for a single Tray (e.g. "THldr1" for "Tray 1" with Tray Type "VT98") and a Tray Holder for four Trays (e.g. "Tray 1" with Tray Type "VT54", "DW96" or "MT96", etc.).

4.2.2. Tray Holders Stack or Stack Cooler with 3 or 6 Drawers

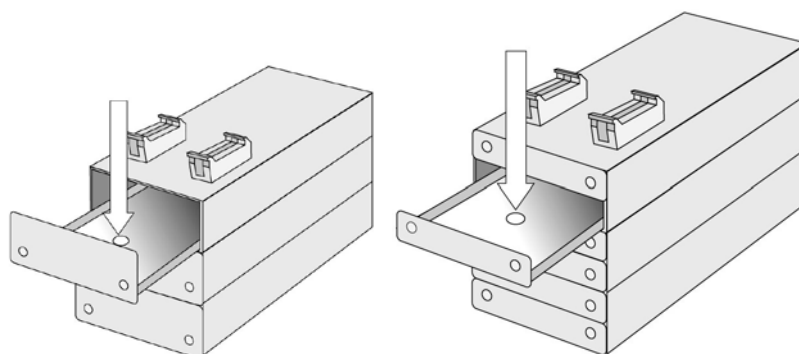


Figure 27. Stack Reference Position

The **Reference Position** for a Stack or Stack Cooler is identical.

The reference position in the case of a 3-Drawer Stack is the hole in the upper drawer and in a 6-Drawer Stack it is in the second drawer from top (same height level), as shown in Figure 27.

4.2.3. Trays

In general it is not necessary to teach a Tray position. The Tray Holder has a teaching position, as described above. A Tray is assigned to the Tray Holder. The numbers (values) for the relevant items are stored in the firmware object "Tray". To complete the combination of a Tray Holder and a Tray, it is necessary to assign the corresponding "Tray Type" to the "Tray." The "Tray Type" contains the geometric data for the Tray and information, such as how many samples are in a row and a column in the Tray. A Tray Type defines the pattern and sampling sequence of sample location within a Tray. For details, see below.

As described above, the Tray is physically placed in the Tray Holder, the firmware assigns the Tray to the Tray Holder and the Tray Type to the Tray. This is routine procedure as long as no special circumstances need be considered, such as customized Trays or Tray Types.

PAL Firmware version 4.1.X now makes a correction possible if the Tray surface is not exactly horizontal and planar but is inclined in one or more axes. At version 4.1.X this is standard and a dialog window pops up the moment the Tray has been checked-out at the corners to verify vial positions and heights. How to correct a possible inclination is explained below.

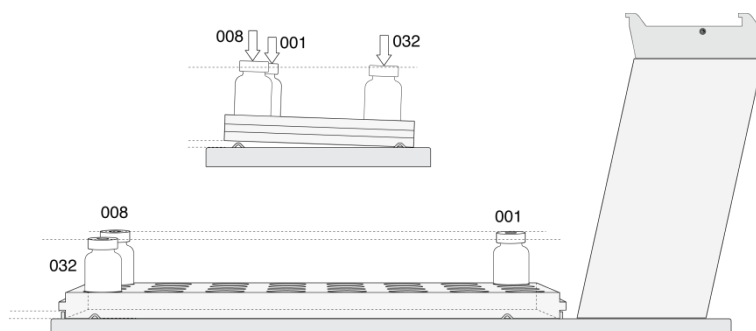


Figure 28. Demonstrating a possible Inclination of Tray in X-, Y-, Z-Axes

4.2.3.1. Definition of a Tray Row and Column

The PAL System defines **Rows** and **Columns** by the order in which samples are treated. A "Row" is not associated with an X- or Y-axis. The definition is visualized below with Tray Type VT32 and DW96:

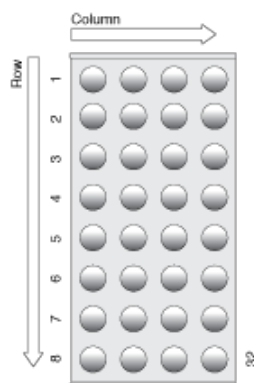


Figure 29. Tray Type VT32

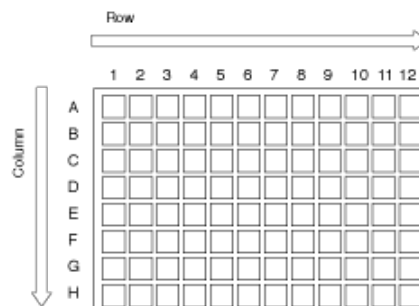


Figure 30. Tray Type DW96

4.2.3.2. Correction for Sample Position in X-, Y- or Z-Axes PAL Firmware version 2.X.X.

The following description of the correction is done by using the path to the "Utilities" section.

After selecting the Utilities function "Trays", verify whether the Tray Type assigned corresponds to the Tray placed into the Tray Holder. If this is verified, the vial positions can be checked at the three corners of the Tray. This is activated by the "F3" function key.

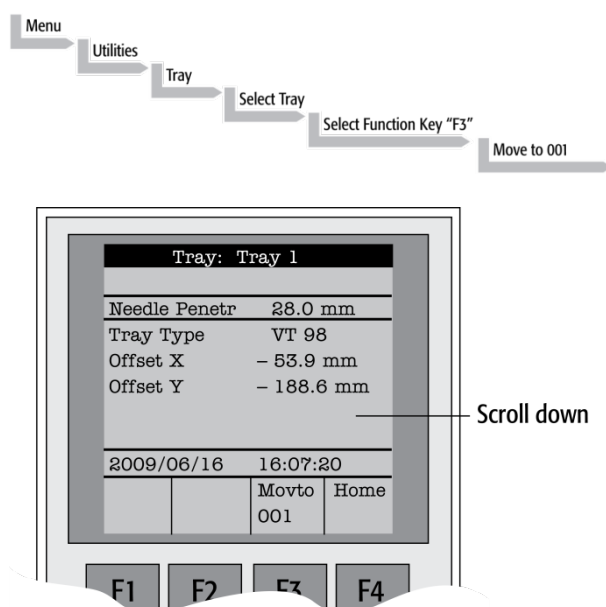


Figure 31. Utilities Function "Trays"

The Injection Unit moves to Tray position no. 001. With the help of the inserted syringe it is possible to check the optimized position of the needle tip matching with the vial or well position.

In case the position is off, make corrections in X-, Y- or Z-positions.

Continue with function key "F3" to move to the next corner to verify this position. If the position matches, continue with function key "F3" to move the unit to the third corner position.

If a deviation of the ideal position is observed in second or third corner, the corrections have to be made on the position no. 001. The offset is bound to position no. 001.

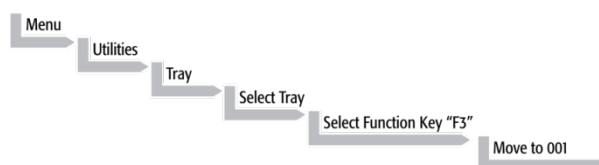
note

Activating one of the parameters Offset X-, Y-, or Z-axis at the positions of second or third corner can bend the syringe needle.

4.2.3.3. Correction for Inclination in X-, Y- or Z-Axes PAL Firmware version 4.1.X or higher

The following description of the correction is done by using the path to the "Utilities" section.

After selecting the Utilities function "Trays", verify whether the Tray Type assigned corresponds to the Tray placed into the Tray Holder. If this is verified, the vial positions can be checked at the three corners of the Tray. This is activated by the "F3" function key.



A dialog window opens, displaying a note to "Adjust offset X-, Y-, Z for Position 001". Continuing in this dialog will provide the user the opportunity to adjust all three axes perfectly by the top of the vial. Please note that this step is only valid for position number 001.

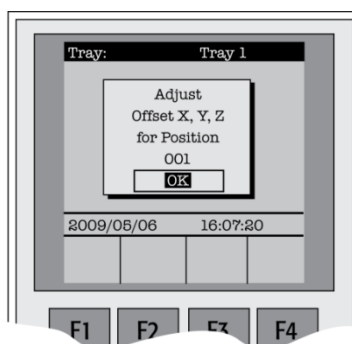


Figure 32. Adjusting "Offset X,Y,Z" for Tray Position 001

To check the next corner of the Tray, activate function key “F3” again, example Tray Type “VT32”, position 008.

The next information provided by the pop-up window asks whether to correct a possible inclination of the “Row”. Continuing the dialog provides the user the opportunity to adjust the three axes perfectly to match the vial top – or in case of a well-plate, the top of the plate.

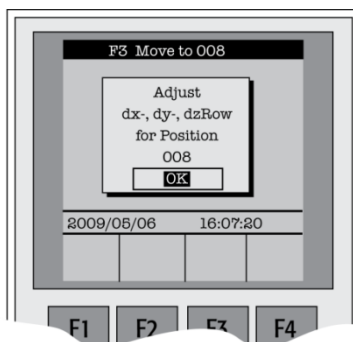


Figure 33. Adjusting Row Inclination at second Tray corner position

The last step will be to move to the next corner of the Tray by again activating function key “F3”. This will be position 32 in the example of Tray Type “VT32”

A possible inclination of the Tray column can be corrected in the same manner as described above.

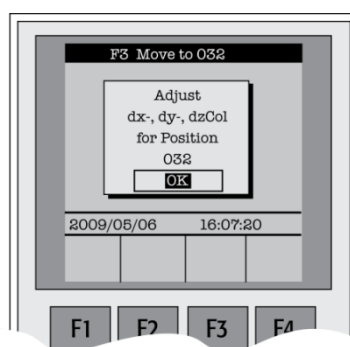


Figure 34. Adjusting Column Inclination at Third Tray Corner Position

The three corner points are now adjusted for a possible inclination of the Tray in any axis. A possible deviation from an ideal axis position for the other vials, caused by variance from the horizontal, is interpolated by the system without further teaching.

note

For routine work using standard vials it is not necessary to compensate for a possible inclination as long as the vial detection is within the “Z-Tolerance” range.

4.2.4. Wash Station: Wash1/Wash2 Reference Point

note

If positions of other types of Wash Stations, such as Active Wash Station, have to be taught, follow the instructions in the specific Addendum of the PAL User Manual.

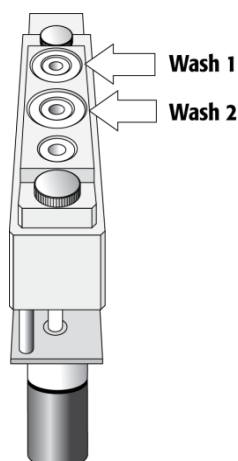


Figure 35. Wash Station Wash1/Wash2 Reference Point

For a Fast Wash Station, the reference positions are the two holes in the wash vial caps (see Fig. 35, Wash1 and Wash2). The lower needle guide should be centered in these holes with the bottom of the lower needle guide lightly touching the surface of the Wash Station assembly.

4.2.5. Wash Station: Waste/Waste2 Reference Point

Injectors (Waste)

note

The Waste positions represent an "Injector" within the PAL software. It is defined in the Object class "Injectors".

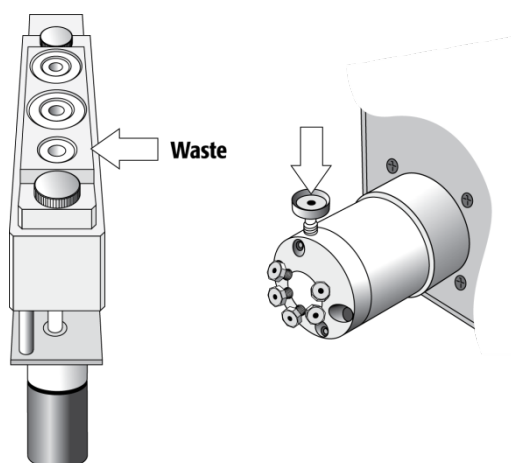


Figure 36. LC Valve and Waste Reference Position

For an **LC Valve** the reference position is the valve needle guide fitting mounted on the top valve port (see Fig. 36).

The lower needle guide of the Injection Unit should be centered in the valve needle guide fitting. Adjust the Z-Position so that the bottom of the lower needle guide just touches the surface of the valve needle guide fitting. **Then reduce the value by 2.0 mm.** See Figure 37.

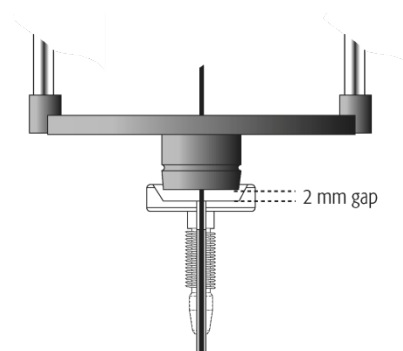


Figure 37. Positioning Z-Axis Needle Guide on Valve Needle Guide

For the **Waste Port** the reference position is a hole (slightly larger than the needle guide) is placed in front of Wash2 (see Fig. 36). The lower needle guide should be centered in this hole with the bottom of the lower needle guide lightly touching the surface of the Wash Station assembly.

note

To adjust the Valve Needle penetration value, see below point 6.2.6. "Injection Valve Needle Penetration".

5. Syringes

5.1. Selecting Syringes

The HTS PAL is shipped with

- 1 PAL SyrLCX100µl; Kit LC Syringe X-Type 100 µL for HTS PAL, consisting of:
 - 1 pc syringe adapter;
 - 1 pc plunger holder;
 - 2 pc syringe SYRX G100-22S-3.

The SYRX G100-22S-3 Syringe gastight 100 µL for HTS PAL, equipped with 22S Gauge needle, is appropriate for injection into the standard CTC injection valve. However, certain applications may require different syringe sizes. Consult the PAL Accessories Catalog in Appendices for details.

Gauge "22S" refers to small internal needle diameter. The "X-type" syringe stands for inertness and for a high number of duty cycles.

5.2. Syringe Priming

It is critical that syringes be primed before beginning sample preparation. Prime every liquid syringe first manually before inserting into PAL system. Afterwards, the syringe can be primed and tested by using the Utility function "Clean Syr".

5.3 Installing a Syringe

note

Before a syringe is inserted, the position "Change Syr" should first be verified. The position "Change Syringe" should not be located above an object where the needle could collide with a vial, as for example.

Path:

Menu/Utilities/Syringe/function key "F3" "Change Pos".

Move the PAL Injection Unit to a location where a collision cannot occur by selecting the X- and Y- axes. The value for the Z-axis is given as a default and a change of this position is not necessary in standard operation.

1. Select Menu and press F1/Chang Syr. The Injection Unit will move to a location that will facilitate installation of the syringe;
2. Place the blue plunger holder into the injection unit;
3. Place the syringe in the appropriate syringe adapter. Pull the plunger out to approximately 20% of its length (See Fig. 38);

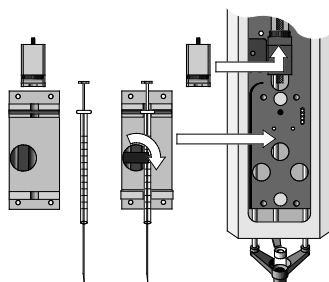


Figure 38. Syringe and Syringe Adapter for Liquid Injections

4. If necessary, loosen the plunger retaining screw in the plunger holder;
5. Move the syringe, installed in the syringe adapter, partially into the Injection Unit. First, guide the needle into the upper needle guide and then into the lower needle guide (See Fig. 39);

6. Insert the plunger button into the plunger holder. Allow the syringe adapter to "click" into place by magnetic force against the syringe carrier;
7. Tighten the plunger retaining screw against the plunger button;
8. Press **"Home"**. The plunger moves down until it hits the mechanical stop. This position is stored as the syringe's zero volume position. The Injection Unit then returns to the HOME position.

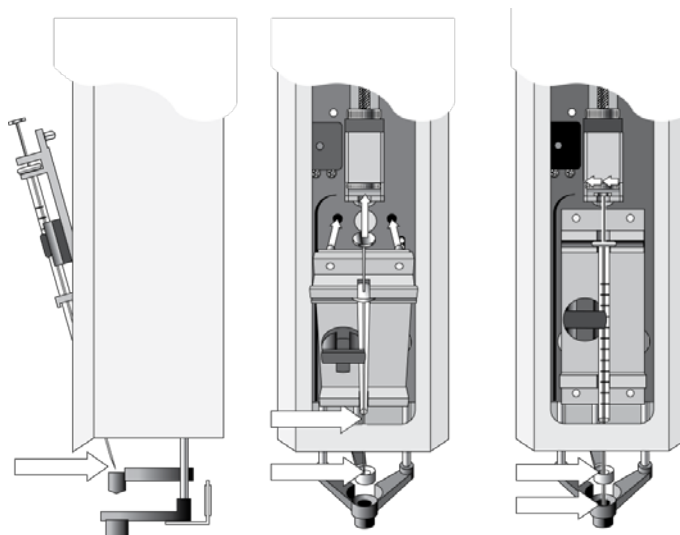


Figure 39. Installing and Removing a Syringe for Liquid Injections

5.4. Removing a Syringe

1. Select "Menu" and press **F1/Chang Syr**. The Injection Unit will move to a location that facilitates removal of the syringe;
2. Loosen the plunger retaining screw. Move the plunger slightly out of the plunger holder;
3. Pull the syringe adapter out and then carefully upward to remove the syringe adapter, with the syringe, from the Injection Unit.

6. Injection Valve

6.1. Valve Drives and Valves – General Remarks

A HTS PAL can be equipped with 1 or 2 LC Injection valves, connected and controlled via the **Auxiliary Interface** (AUX1, AUX2). If more than two valves have to be configured, or if an auxiliary Interface is occupied by another module, such as a Dilutor, then the Multi Position or Serial Valve Drives are required. The Serial Valve Drives are connected at "SER2" interface with the PAL System or interface "MODBUS" with the PAL-*xt* system.

The standard LC injection valve is a six-port Cheminert valve (Valco/VICI). On customer demand, CTC Analytics can also supply other valve types, such as Valco W-type, or valves with various ports, 4-port valves (with internal loop) and 10-port valves.

The six-port valve is connected to the detection system according to the flow path shown below. Plumbing diagrams for other available six-port injection valves are provided below as well.

Details are described in the Addendum of PAL User Manual "Valve Drives and Valves". See also poster "Tips and Hints for PAL Systems".

6.2. Injection Valve Flow Path

The six-port valves are connected to the detection system according the flow paths as shown in Figures 40 to 42.

6.2.1. Standard LC Injection Valve, Cheminert 6-Port

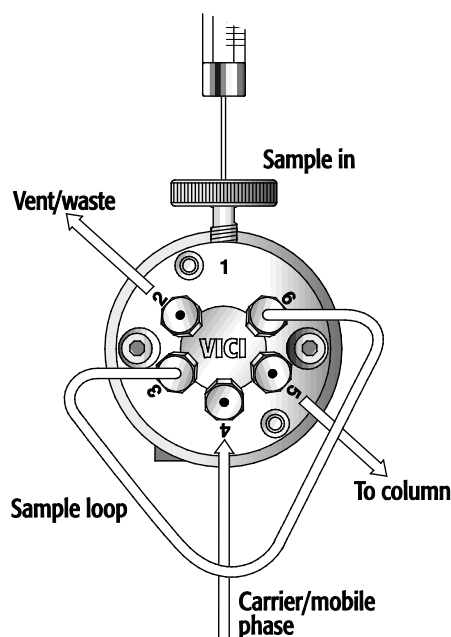


Figure 40. Flow Path LC Injection Valve Cheminert Type

The standard LC Injection Valve is a six-port two-way switching Valve with a flat rotary plate and has a special needle guide.

Valco / VICI Cheminert	Flat Plate Rotary Valve
Stator Material:	Stainless steel 316
Rotor Material:	Valcon H (inert mix-polymer)
Port Size:	1/16 inch
Fittings:	Valco 1/16 inch Ferrules and Nuts
Actuator:	PAL Valve Drive (Micro-Electric Actuator)
Loop Size:	20 µL (shipped), other loop sizes available
Bore Size:	0.25 mm
Port to Port Volume:	320 nL for vertical port, 75 nL for standard ports, 75 nL for engraving

note

Sample loops of the different valve types are not interchangeable.

6.2.2. Valco W-Type 6-Port Injection Valve

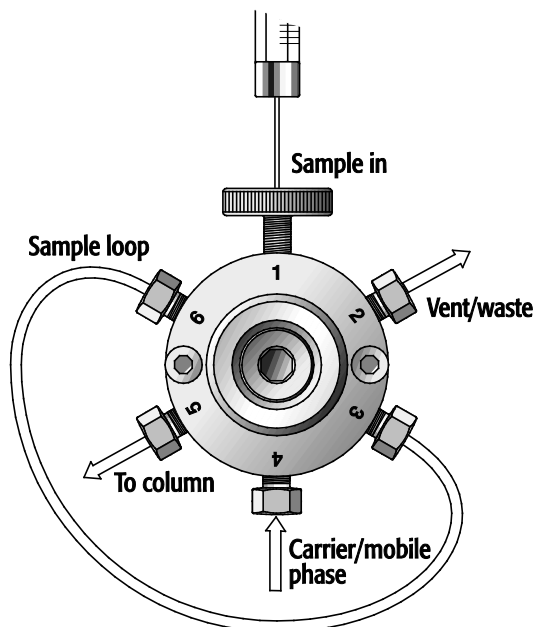


Figure 41. Flow Path LC Injection Valve W-Type

The LC Injection valve, Valco Type W, is a six-port two-way switching valve with a conical rotor and a the special needle guide.

Stator material:	Stainless steel 316
Rotor material:	Valcon H (inert mix-polymer)
Port size:	1/16 inch
Fittings:	Valco 1/16 inch Ferrules and Nuts
Actuator:	PAL Valve Drive (Micro-Electric Actuator)
Loop size:	20 µL (shipped)
Bore size:	0.40 mm
Port to port volume:	155 nL for all ports, 390 nL for engraving

note

Sample loops of the different valve types are not interchangeable.

6.2.3. Rheodyne 6-Port Injection Valve PD7991

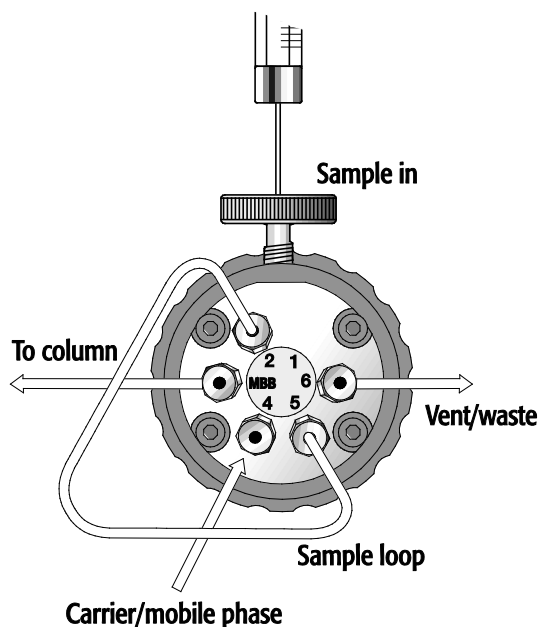


Figure 42. Flow Path LC Injection Valve ‘Rheodyne PD7991’

The Rheodyne PD7991 six-port two-way switching valve is delivered with a CTC Needle Guide and Needle Seal. Valve pod diameter 27 mm.

Rheodyne Valve	Flat Plate Rotary Valve
Stator material:	SPC-4 (special plating on Titanium)
Rotor material:	RPC-10 (proprietary PEEK blend)
Bore size:	0.20 mm (0.008"); Vertical Port 0.25 (0.010")
Port size:	1/16 inch
Port ferrules:	Swagelok Front- and Back Ferrules
Needle seal ferrule:	Rheodyne
Nuts:	Rheodyne nuts
Loop sizes:	5, 10, 20, 50, 100 µL
Maximum pressure:	1034 bar, 15,000 psi
Port to port volume:	294 nL for vertical port; 195 nL for standard ports

note

Sample loops of the different valve types are not interchangeable.

6.2.4. Rheodyne 6-Port Injection Valve PD718-313

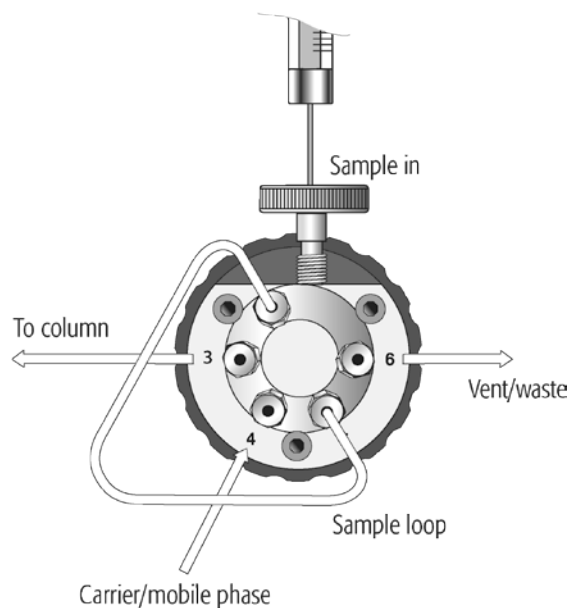


Figure 43. Flow Path LC Injection Valve ‘Rheodyne PD718-313’

The Rheodyne Injection Valve PD718-313 is a SupraLife™ 2-position, 6-port Rapid Replacement Pod equipped with a vertical inlet port, delivered with CTC Needle Guide and Needle Seal. Valve pod diameter 32 mm.

Valve Stator:	Coated stainless stator
Rotor:	RPC-13 Polyimide based rotor seal
Bore Size:	Vertical Port: 0.25 mm (0.010") Ports 2 to 6: 0.20 mm (0.008")
Volume for Ports and Engraving:	Vertical Port: 0.75 µL Ports 2 to 6: 0.07 µL Engraving: 0.05 µL (standard engraving)
Valve Volume	Full Loop: 0.87 µL Partial Loop: 0.82 µL
Connections:	10-32 male threaded fittings, 1/16" tubing OD
Port Nut/Ferrules	Swagelok Nut and Front-Back Ferrule
Maximum Pressure:	1200 bar (18000 psi; 120 MPa)
Standard Loop:	2 µL; Loop ID: 0.13 mm (0.005")

note — Sample loops of the different valve types are not interchangeable.

note — The Agilent specific Rheodyne Valve with Agilent PNo. 5067-412 is connected in the same way to the HPLC system as shown in Figure 43.

6.2.5. Valve Needle Guide and Needle Seal

All valves are equipped with a special valve needle guide fitting. This fitting has a wide diameter to mate with the syringe needle guide on the injection unit. The valve needle guide also has a countersunk hole to facilitate insertion of the syringe needle into the injection port.

Figure 44 shows the example of the setup with the standard valve, Cheminert type.

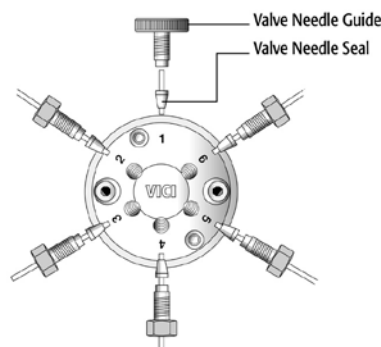


Figure 44. Valve Needle Guide and Valve Needle Seal

The valve needle guide holds the needle seal. The needle seal, which is a short length of FEP tubing, forms the seal around the syringe needle. A stainless steel ferrule is tightened around the FEP sleeve to ensure a leak-proof fit.

note

To ensure reproducible sample injection and minimize carryover it is critical that:

- *The valve needle guide and the valve needle seal be installed properly.*
- *The valve needle seal be changed on a regular interval, details see below.*
- *The needle penetration depth be set accurately (see point 6.2.6. "Injection Valve Needle Penetration").*

To specify a limit number of maximum penetrations into the Needle Seal is not practicable. It is advised to check the tightness of the seal daily or weekly when first using the PAL System to gain experience with the specific use in the laboratory related to the application.

The following simple test provides assurance of tightness:

- Take the Needle Seal out of the valve port.
- Manually insert a syringe needle gauge 22 (or Gauge 22S) from top down into the tube, passing the sealing point of the ferrule.

If a restriction is observed, continue to use the Needle seal.
If not, replace the Needle Seal.

6.2.5.1 Interval to Replace Needle Seal

The interval to replace the Needle Seal depends on the number of penetrations. Two factors may be considered for the decision to replace the Needle seal:

- Leak, seal not reliable:
Remove the Needle Seal from the inlet port and insert a syringe manually with the corresponding needle gauge (standard Gauge 22 OD 0.72 mm). Move the needle below the seal point of the ferrule. If no resistance is observed at this point, replace the Needle seal.
- Carry-over
In case of any doubt of possible contamination of the Needle Seal with a compound, replace the Needle Seal.
Contamination can occur if the sample solution is accidentally dispensed too fast into the valve system. The restriction of valve and loop may cause backpressure and the sample solution can be forced backwards into the inlet port of the valve.

note

PAL Firmware (version 2.4.X or higher) provides a counter for the number of injections performed with the PAL System. This counter monitors the valve switches and not the number of penetrations into the injection port, e.g. for cleaning the valve an extra penetration is required. It is advisable to monitor this counter in conjunction with the test for the tightness of the Needle Seal as described above.

- *After running routinely a few weeks, the warning limit for the "Inject Counter" gradually becomes more evident and will be a valuable tool for the user in routine work.*
- *Path: Menu/Info/Maintenance/Inject Limit ("Inject Counts" reflects the actual number of injections).*

6.2.5.2. Part Numbers for Replacement Needle Seals

PNo.	Description
PAL NdlSeal	Standard Needle Seal, pkg of 10. FEP Tubing transparent, Ferrule sst., Needle Gauge 22 (OD 0.72 mm), for Valco/VICI sst Valves Cheminert and W-type.
PAL NdlSealP	Needle Seal, pkg of 10. FEP Tubing transparent, Ferrule PEEK., Needle Gauge 22 (OD 0.72 mm), for Valco/VICI PEAK Valves Cheminert-type.
PAL NdlSeal-19	Needle Seal, pkg of 10. FEP Tubing blue, Ferrule sst., Needle Gauge 19 (OD 1.06 mm), for Valco/VICI sst Valves Cheminert and W-type with bore size 0.75 mm (large volume injection application).
PAL NdlSealR	Needle Seal, pkg of 10. FEP Tubing transparent, Ferrule sst., Needle Gauge 22 (OD 0.72 mm), for Rheodyne Valve 6-port, PD 7991-type.

6.2.6. Injection Valve Needle Penetration

note

Before performing the following steps, make sure the Object Positions X-, Y-, Z for LC Vlv1 (LC Vlv2) are properly defined and a syringe adapter, including a syringe, is inserted in the Injection Unit (see points above).

Complete the following steps to define the Valve Needle Penetration Depth:

1. In the Object Class **Injectors** choose the Object **LC Vlv1**. The following screen is displayed:

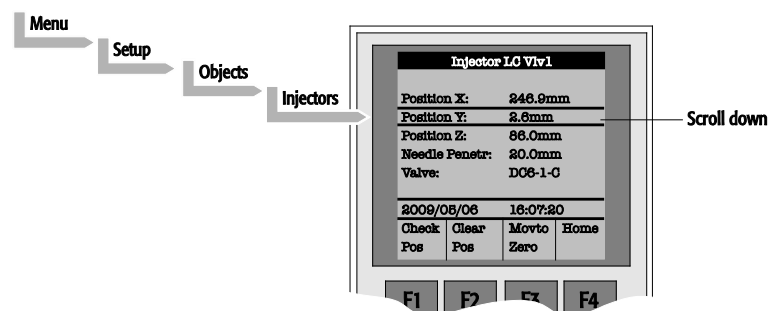


Figure 45. Menu Screen Valve Needle Penetration Depth

2. Press the F1 button **Check Pos**. The Injection Unit moves to the previously defined **LC Vlv1** position;
3. Highlight the item **Needle Penetr:** with the cursor bar and press **ENTER**;
4. **Slowly** rotate the outer knob to adjust the Needle Penetration Depth. The syringe moves down stepwise into the Injection port;
5. When the syringe needle tip enters the valve needle guide, **slow down** the Z movement again. Always observe the syringe needle during this operational step;
6. Move down stepwise until you notice a "**click**" sound inside the Injection Unit. **STOP** the Z down movement immediately;
7. Rotate the outer knob **two steps** in the opposite direction and press **ENTER** to save the Needle Penetration Depth value;
8. Press Function Key **F3** "Movto Zero";
9. Verify the defined Needle Penetration Depth value by repeating Step 2 and 3.

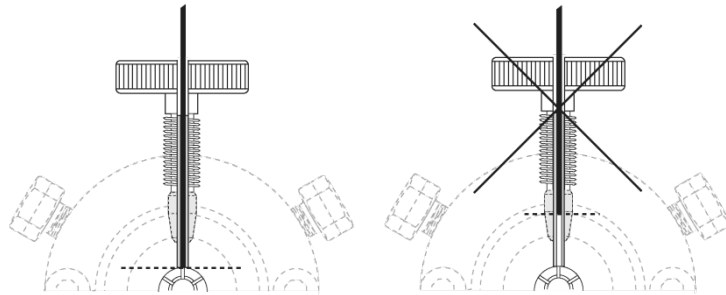


Figure 46. Needle Penetration in Valve Inlet Port

note

The setting of the Needle Penetration can also be achieved in the "Utilities" section.

Path: Menu/Utilities/Injector/LCVlv1

*Select function key **F3** "Moveto Inj" and activate "**Needle Penetr**"
Continue as described above..*

note

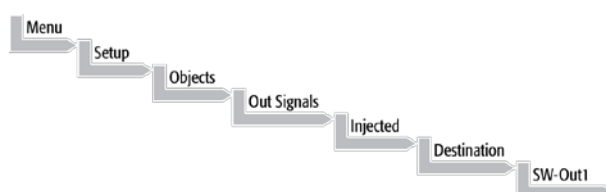
After all positions have been set and the Valve Needle Penetration has been adjusted, perform a backup of the existing configuration (see point 8 below, "PAL Software Program").

7. Interfacing the HTS PAL to Other Devices

7.1. Synchronization and Output Signals

Synchronization Signals (**Sync Signals**) are inputs that tell the HTS PAL when to wait or proceed with a sample-processing step. Output Signals (**Out Signals**) are sent from the PAL to external devices to indicate status or completion of particular processing steps. These signals are classified as Objects. Physical Events (e.g. TTL-In1) are also Objects and may be assigned to named signals. PAL Cycles require that certain signals such as **"Start"**, **"Inject"**, and **"Injected"** be defined. See the next table below for the PAL Events and signal assignments associated with the standard PAL **"LC-Inj"** and **"LC-Cut"** cycles.

Certain types of integration of the PAL system into data handling or control software, such as ChemStation, Xcalibur, Galaxie or Chromeleon, accomplish synchronization of the Ready/Start signal directly via software control (RS232/LAN). A synchronization cable is not required and the Sync Signal **"Start"** must be set to **"Immediat"**.



To assign a physical Event (e.g. SW-Out 1) to an existing signal Object (**"Injected"**), complete the following menu selections:

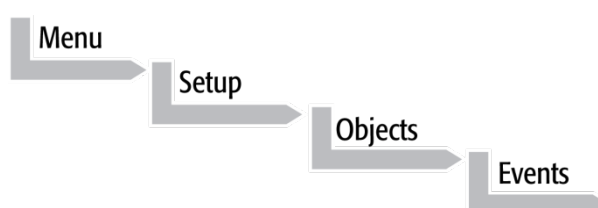
PAL Systems are shipped with all Cycle events pre-defined, as shown in the table below. If a different physical signal needs to be used, then it will be necessary to assign a new Event to the Object signal.

If a signal is to be ignored, then its corresponding Event must be set to "Immediat".

Standard Assignment for HTS PAL Injection Cycles	Description	Default Events	INTERFACE 1 Pin #
Start JobQueue (Sync Signal)	Start a Job Queue (Job). Prerequisite is a defined "Job" with a method assigned. Useful for automated, unattended, timed sampling.	Immediat	
Start (Sync Signal)	Start a cycle (Input from GC or data system)	Immediat ¹	7 8(GND)
Start2 (Sync Signal)	Continue the cycle "GC-Dual" for the second sample	Immediat (Ignore)	
Inject (Sync Signal)	Inject READY to INJECT	Immediat (Ignore)	
Inject2 (Sync Signal)	Inject the second sample for "GC-Dual" cycle	Immediat (Ignore)	
Injected (Out Signal)	Activated at the moment the sample has been injected	SW-Out1	3 4
Injectd2 (Out Signal)	Activated at the moment the second sample has been injected	Off	
Running (Out Signal)	Active as long as the Job Queue is being processed and the PAL is not in an error state	Off	

1) If used to synchronize with Sync cable, change setting to "TTL-In1"

If an item of the class "Sync Signal" is assigned to an output signal, such as "TTL-In1", then this TTL contact must be defined as either "Active High" or "Active Low", as expected by the HPLC system. This is defined in the PAL Firmware class "Events".



Select the corresponding item and set the mode accordingly.

The setting is provided with the schematic description of the LC Sync Cable if a dedicated cable is ordered.

Normally, a non-specific LC Sync Cable is supplied that has the PAL and PAL-xt "INTERFACE 1" connector mounted and the HPLC system side has four open leads.

8. PAL Software Program

8.1. PAL Loader Program

The purpose of PAL Loader Software is to create a backup file of the complete PAL System Firmware. The core software (firmware) and all PAL Firmware Objects, including all settings (Items), the local methods, and jobs are saved in one file.

The PAL Loader software has a second function of loading the firmware or a complete backup file to a PAL system.

The PAL Loader software has always been a part of the PAL System. The following PAL Loader Software versions are in use:

- PAL Loader Version 1.0.1
- PAL Loader Version 1.1.1

A new PAL Loader software, "Loader" version 2.1.1 (or higher) has been developed for the PAL-*xt* system.

The PAL-*xt* system requires PAL Firmware 4.1.X or higher, which calls for the new "Loader" software.

The new PAL Loader Software is backwards compatible. The software can be used for all PAL Firmware versions.

The name of the *.exe file has been changed intentionally to avoid conflicts when old and new versions are installed on the same computer:

- PAL Loader version 1.1.1: PALLOAD.exe
PAL Firmware version up to and including 3.X.X
- PAL Loader version 2.1.X: Setup PALloader (.exe)
PAL Firmware version as of 4.1.X
but backwards compatible with lower versions.

Details are described in: "Addendum to PAL User Manual, PAL Loader Software Version 2.1.X, Installation and Operation".

8.2. PAL Object Manager Software

The PAL Object Manager software is used to load a new PAL Firmware Object to a system after a new module (hardware module) has been added to the PAL System.

The PAL Object Manager software is the software used to handle the so-called PAL Object List.

The software version 2.2.1 or higher has been developed for the PAL-*xt* System that, in addition to serial communication, also permits LAN communication (TCP/IP). The software is backwards compatible and can be used for all PAL Firmware versions.

The PAL Object Lists have to match the corresponding PAL Firmware version, as shown in the list below:

- PAL System Firmware Versions 2.X.X
PAL Object Lists Rev. K (or higher)
- PAL System Firmware Version 3.0.X
PAL Object Lists Rev. K (or higher)
See specific Object Lists for this FW Version 3.0.X.
- PAL-*xt* System Firmware Version 4.1.X (or higher)
PAL-*xt* Object Lists Rev. B (or higher)

The two Object Lists for the PAL and PAL-*xt* Systems can be loaded with the same PAL Object Manager software. This simplifies the handling in cases where the PAL and PAL-*xt* Systems are in use within the same working environment.

Detailed information is available in the 'Addendum to PAL User Manual PAL Object Manager Software'.

9. Establishing Communication with Computer

The PAL System allows a serial communication protocol with a PC. As a new feature, the PAL-xt System provides LAN communication, also referred to as "TCP/IP" or "Ethernet".

The PAL-xt System requires a dedicated "APR Control-xt" board and PAL Firmware version 4.1.X or higher.

9.1 COM Port Settings

The port settings are normally defined in:
Windows\Control Panel\Device Manager\Ports.

The standard settings for the serial communication are shown in Figure 47. It is important to understand that the application (e.g. PAL Loader Software) does actively set the communication parameters, and the baud rate is set for optimized use.

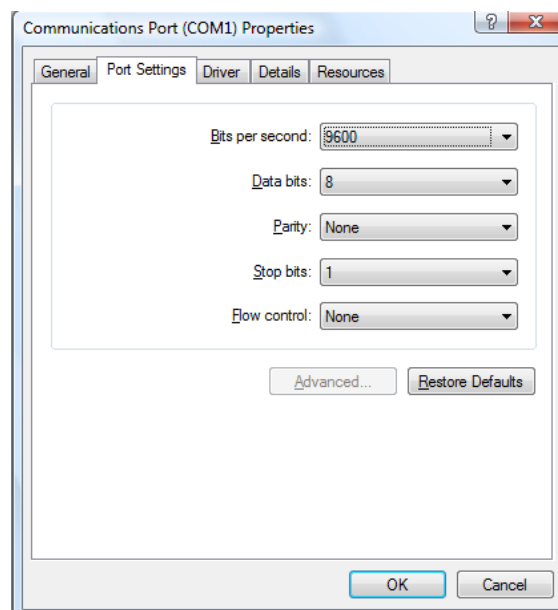


Figure 47. COM Port Settings

A quick way to check whether serial communication with the PAL System can be established is to use the PAL Loader software. For details see "Addendum to PAL User Manual PAL Loader Software".

9.2 Setting up LAN Communication

Select the firmware “Communication” class by the following path:

Menu/ F3-Setup/Communication

note

Menu/ F3-Setup/Communication
See detailed description below under point 10.

The system automatically searches for the MAC address when the “Setup Communication” window is accessed.

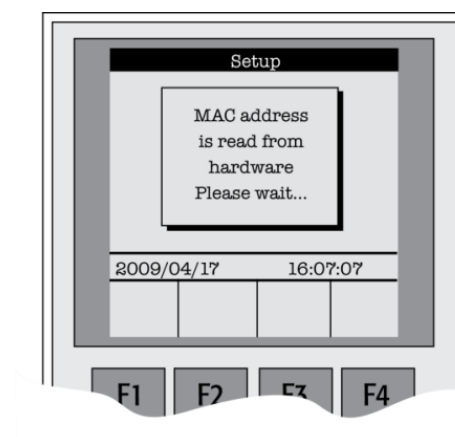


Figure 48. Reading the MAC Address from the Ethernet Communication Port

This search for and reading of the MAC address takes approximately 10 to 15 seconds. If successful, the MAC Address is stored in the system firmware and can be viewed on the terminal as follows.

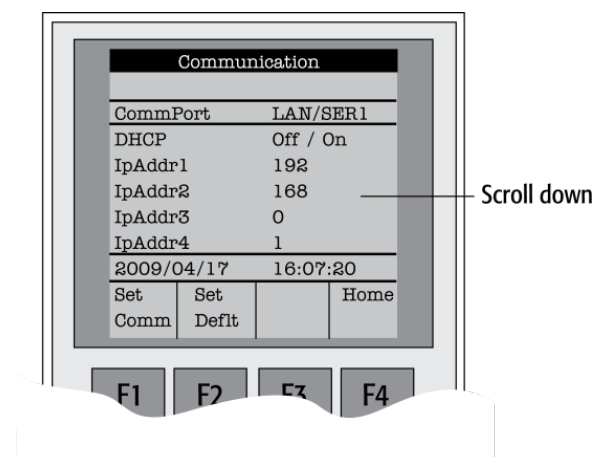


Figure 49. PAL-*xt* Communication Settings

Pressing function key “F1”, “Set Comm” sets the selected communication mode. The same is achieved by pressing “ESC” or “Home”.

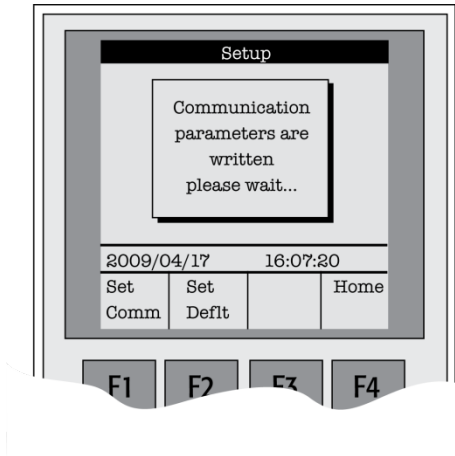


Figure 50. Setting Communication Mode

9.2.1. Explanations for the various settings for the Communication Protocol

Parameter	Explanation	Remarks
CommPort	Setup for serial (SER1) or LAN communication.	If serial communication is selected, all other parameters in PAL- <i>xt</i> Firmware "Communication" class are ignored.
DHCP	= Dynamic Host Configuration Protocol. If set to "Off", the IP address is provided by the user, see IPAddr1 to 4. The user can ask the network administrator for a suitable IP address. If set to "On", an IP address is dynamically sought throughout the provided network.	It is advisable to use a fixed IP address, set the "DHCP" parameter to "Off". In this mode the PAL- <i>xt</i> System always has the same fixed IP address. Troubleshooting is easier for the network administrator. See also special remarks below.
IPAddr1 to 4	Enter the IP address divided into four blocks, example IP default Address: 192.168.0.1.	The IP address is a fixed PAL- <i>xt</i> System address. The IP address is often provided by the network administrator.
SubNet1 to 4	SubNet mask for network configuration.	The SubNet mask must be provided by the network administrator.
TCPPort	This parameter is read only, no changes possible.	The network administrator must be informed about this setting. The port must be cleared of firewall protection to enable communication.
StdGateway 1 to 4	If Gateway is used in network, the Gateway IP address (switch, hub) has to be entered.	Gateway is used if independent networks need to communicate interactively. Communication within the network is provided by a hub or switch, defined as "Gateway".
MACAddr1 to6	The unique MAC Address for the PAL- <i>xt</i> System is read and entered into this PAL- <i>xt</i> communication protocol. This is a read only parameter field.	The MAC address is provided by the Ethernet communication hardware. The address is also visible beside the read-out from the terminal on the label affixed to the Ethernet module on the PCB "APR Control- <i>xt</i> ".

9.2.2. Special Remarks to the above listed Parameters

DHCP:

If “DHCP” mode is active, an automatic search for the IP address is activated. If a free IP address is found, the communication between the PAL-*xt* System and the network becomes established. The new IP address (found through “DHCP” search) is immediately entered into the PAL-*xt* Communication protocol as seen from the local terminal. The parameters “IPAddr1 to 4” are not updated until one opens the communication menu again.

The Setup for the PAL Loader software requires entering the IP address or hostname. The dynamically provided IP address is displayed on the local terminal. As an alternative, the following setup procedure can be used:

Prerequisite: PAL-*xt* setting in “Communication” class: DHCP = On.

Open the “Setup” window and enter the following name in the “Hostname or IP Address” field: CXXXXXX. The “Xs” being the last six characters of the MAC address, which is known from the parameters MacAddr4, MacAddr5, and MacAddr6 for the PAL System.

If a MAC address only consists of one character, insert a 0 in front of it. If, for example, MacAddr4=BA, MacAddr5=35 and MacAddr6=3, enter CBA3503 and not CBA353.

9.3 Troubleshooting for Serial or LAN Communication

Both communication protocols are described in detail in the “Addendum to PAL User Manual PAL Loader Software”.

10. Special Functions

This section describes special functions which can be activated by the “PAL Extended User Mode”.

The purpose of having two software access levels is to display discrete items and sections of the firmware at each level. Settings which need to be done rarely, perhaps at the time of installation of the PAL System, are hidden at level 1 (User Level) and revealed at level 2 (Extended User Level). This also protects the PAL System in group use. Nevertheless, the important points should be known by the user and are described below.

10.1. How to Access “Extended User Mode”

Extended User Mode can be accessed by the following path:



The above path as shown is an abbreviation for the following steps:

- Menu/ scroll the cursor to “Setup” /
- Press function key “F3” /
- Activate “Setup” by pressing the center of the selector knob.

In this PAL User Manual or in technical notes, only the following will be referred to:

Menu/F3-Setup/.

10.2. Section Extended User Mode or “F3-Setup”

The path to access this section is shown below.

This “Setup” section at the Extended User Level provides various options to access other classes which are not visible at the User Level. Some classes are known but may show some new items. Details are described below.

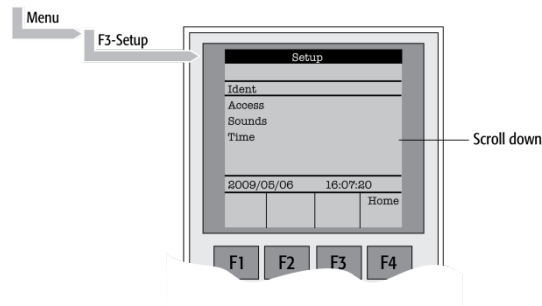


Figure 51. Selecting “Setup” in Extended User Mode

Object	Description
Ident	The “Identification” of the system provides the opportunity to assign Users, site, and system names. The serial number of the PAL System can be entered at this level. Remark: After loading a fresh PAL Firmware Backup file, the SNo. is displayed as “XXXXXX”.
Access	Access can be selectively opened or limited to different users for the “Job”, “Method” or “Setup”.
Sounds	The “Beep” sound can be adjusted to specific needs. For safety reasons it is advisable to keep the default settings, especially the “Warn Move,” turned ON to signal the start of the PAL System to the user.
Time	The PAL internal clock can be set. Remark: If the clock is fast, reset all items, from “Year” to “Seconds” and use the mandatory function key “F1” “Set Time”.
<i>Communication</i>	The communication mode, serial or LAN, can be selected and conditions are defined. For details see Addendum PAL Loader Software.
System	Basic parameters can be predefined for specific needs. Details see below.
Service	Basic service tests can be activated. Details see below.
Objects	Accessing the PAL Firmware class “Objects” in the Extended User mode provides more detailed possibilities for object items. At this level an Object can be copied or deleted by using the specific function keys. This provides quick access to add e.g. a second or third injector.

Items displayed in “*italic*” are available beginning with PAL Firmware Version 4.1.X.
Items displayed in “**bold**” are explained in detail below.

10.2.1. System

The following “System” Items can be changed by selecting the particular item. Beginning with PAL Firmware Version 4.1.X, an intermediate step was added. After selecting “System”, the new “Settings” level follows. Activating “Settings” opens up the described Items below.

Item	Description
Syr Detect	The syringe detection can be turned off in cases of sensor failure or if a special syringe with unknown ID is installed. Turning OFF the syringe identification sensor automatically displays a dialog box enabling the selection of syringe identification manually.
Start Ref	This item provides the choice of referencing all axes at the start of the system or suppressing the referencing. It is advisable to use this function actively to detect a possible loss of steps.
Stop XY Error	This function allows turning off the automatic recovery of the PAL system after detection of a collision (loss of steps of a stepper motor). Stop XY Error = ON: Automated recovery turned OFF Stop XY Error = OFF: Automated recovery turned ON In PAL Firmware version 2.3.X the new feature that recovers automatically after detecting a collision has been implemented. Firmware version 2.6.2 provides the possibility of disabling automated recovery. If recovery is turned OFF, the PAL system always checks its position before moving to the injection port for injection. This can lead to an extra move, crossing over the X-Y-axes sensors – if the injection port is at the opposite end of the X-axis relative to the sample location, (zero X-axis position in-between sample location and injection port). For critical application fields, e.g. clinical analyses, it is advisable to turn off the automated recovery; Stop XY Error= ON.
PlgPathCheck	The plunger travel path is monitored to ensure that the plunger tip reaches the syringe zero point in all cases – compared to original plunger referencing and defining the syringe zero point. If an error is detected, the PAL System stops operation. This feature is useful if sample solutions with particles need to be handled, or if the syringe type is not adequate for the solution composition, or if the syringe plunger is blocked or even bent, such an error will be recognized and the system will come to an emergency stop.
PlgChnge Pos	Changing a syringe using the Menu function “Chnge Syr” moves the plunger up to the position specified by this item. For normal use, accept the default values.
Init Syr at	The syringe plunger can be initialized (referenced) at “Home” or “Waste” position. If samples with a high danger of toxicity are treated, it is advisable to use the “Waste” position for referencing.
Inj Signal	An Autosampler is usually the master in a total chromatographic system. The other components send a “Ready” signal to enable a start of the Autosampler. At the moment of injection a Start signal is sent from the PAL System to the other component(-s) of the entire system. With this “Inj Signal” item the status at which the signal is sent out can be defined. The syringe is filled with the defined sample volume. PlgUp = Start signal at the moment the plunger starts moving down for injection. PlgDown = Start signal at the moment the plunger reached zero point from syringe. (recommended for large volume injection, but not in combination with Agilent Chemstation.) ValveSw = Start signal sent at the moment the injection valve is switched, HPLC technique. PreInj = Start signal sent at a time before injection, as with a sample preparation device started before a GC or LC system. Minus time relative to chromatographic start time.

Vial PrePress	This item can be activated to avoid a vacuum if a relatively large amount of sample is taken out of a small volume vial. If e.g. a volume of 50 µL is specified for injection, the PAL system first takes 50 µL ambient air and "injects" this volume into the sealed vial, causing overpressure in the vial. After this step, the sample volume can be aspirated without forming a vacuum. This functionality is only valid for liquid sampling, not for the Headspace technique. Starting with PAL Firmware version 4.1.X this item is also active in combination with Cycle Composer.
LC-Inj	Standard cycle for HPLC technique. Details on method see Appendices, point 3, "Injection Cycles" and point 4, Flow Chart "Firmware Overview"
LC-Cut	Cycle for column switching with two valves, HPLC technique. Both valve drives have to be controlled through "AUX" interfaces. Details on method parameters, see Appendices, point 4, Flow Chart "Firmware Overview"
GC-Inj	Standard cycle for GC technique. Details on method parameters see Appendices, point 3, "Injection Cycles" and point 4, Flow Chart "Firmware Overview".
GC-InS	Standard cycle covering GC Sandwich technique. Details on method parameters see Appendices, point 3, "Injection Cycles" and point 4, Flow Chart "Firmware Overview".
GC-Dual	Cycle for GC technique which allows injecting two samples in two different injectors. The start signal is sent after injection of both sample solutions. Details on method parameters see Appendices, point 3, "Injection Cycles" and point 4, Flow Chart "Firmware Overview".
HS-Inj	Standard cycle for GC headspace technique. Details on method parameters see Appendices, point 3, "Injection Cycles" and point 4, Flow Chart "Firmware Overview"
SPME	Standard cycle for GC SPME technique, Solid Phase Micro Extraction, Fiber technique. Details on method parameters see Appendices, point 4, Flow Chart "Firmware Overview"
TTS Sotax	The two cycles are dedicated cycles for "dissolution applications". TTS cycle is used for transdermal patches and the Sotax cycle is used for tablet dissolution

Items displayed in "*italic*" are available beginning with PAL Firmware Version 4.1.X.

note

Standard injection cycles are selectable and activated directly from the PAL System. Any deviation from a standard cycle, a Cycle Composer Macro, or Cycle Editor (ICC-CE) Cycle must be programmed for customized requirements.

note

In PAL Firmware versions < 4.0 the standard cycles are grouped in Item "Cycles".

10.2.2. Service

The following “Service” items may be changed by selecting the particular item:

Item	Description
Check Motors	Every stepper motor can be moved separately. This function is useful to check out a specific motor or to perform an endurance test after a repair. The Start and Stop positions of the test path can be selected. The motor Current, Speed, and Acceleration are selectable (accept default value to be sure). A Pause time can be specified. A Cycle Limit and Actual Cycle Counter are useful tools for endurance tests.
Test Head ¹	This tests the functionality of the PAL Injection Unit (“Head”). Two tests can be activated by the function keys: “F1” Check Plg : The stepper motor of the plunger drive is tested. Sensor check. “F2” Check Z : The vial detection sensor and “Needle Guide Blocking” function is tested. These tests are only required if any erratic behavior of the PAL System is observed. In such cases contact a representative of CTC Analytics AG.
Test Switches	X-Limit = Actual status of X-axis sensor. Move the X-Y-Carriage manually across the limit switch to verify activation of the sensor. Y-Limit = Actual status of X-axis sensor. Move the Y-axis manually to the Y-zero point (at X-axis), crossing over the limit switch to verify activation of the sensor. Z-Limit = Actual status of Z-axis sensor. Move the syringe slider assembly manually up to the zero Z-axis point, crossing over the limit switch to verify activation of the sensor. Aux1 Limit = Actual status of Aux1 limit sensor Aux2 Limit = Actual status of Aux2 limit sensor Plg -Pos = Actual status of Plg -Pos Needle Guide = Actual status of needle guide sensor

Items displayed in “*italic*” are available beginning with PAL Firmware Version 4.1.X.

¹ Please note that the service test ‘Test Head’ is executed in the same way, independent of the PAL Firmware version. However the test evaluation is different between firmware versions 2 - 3 and version 4.
The updated PAL Service Manual, Edition 1.1, will include the PAL-*xt* System and will explain these differences.

10.3. Section “F3-Setup” / Objects

The same as is described above applies for the section “Objects” opened in Extended User Mode. New classes are visualized and known classes may contain new items accessible only on the level of the Extended User Mode. To open this level, use the following path:

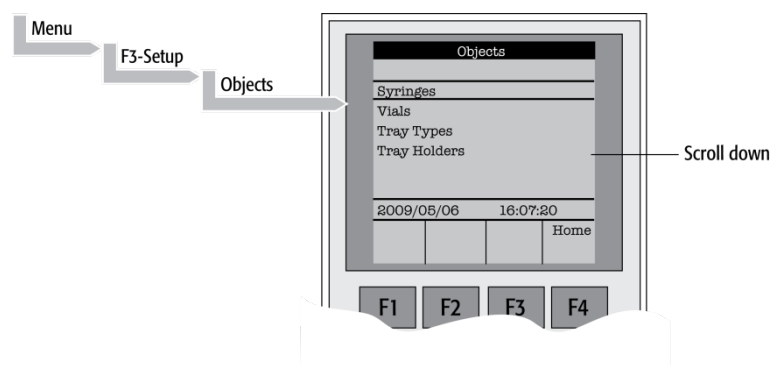


Figure 52. Selecting “Objects” in Extended User Mode

Object	Description
Syringes	At this level all loaded syringes are selectable. At the “Utilities” user level only the active syringe is visible.
Vials	The Firmware Objects accessed on the PAL Extended User Mode have more specific items selectable than at the User level. Tolerances or ranges such as, e.g. “Maximum Penetration” can be defined and limited for the user such that this value cannot be exceeded. In the Object “Tray Types”, details for the various Items are described more closely.
Tray Types	The object class “Tray Type” is only accessible via the PAL Extended User Level. All loaded Tray Types are visible and selectable. Details, see below.
Tray Holders	The Firmware Objects accessed on the PAL Extended User Level have more specific items selectable than at the User level. Depending on the type of Tray Holder, e.g. an Access and Restore Path or a Heater and Agitator (motor) is assigned. Typical example, the Tray Holder “Agitator”.
Trays	All loaded Trays are visible and accessible. A Tray must be assigned to a Tray Holder. A “TrayTypeGroup” identification checks if the specified Tray Type is allowed in this combination. The offsets X-,Y-, Z and the inclination corrections for a row or column are explained in the “Utilities Functions” section. The “Path Offset X-,Y-, Z” is used only if a “Path” is assigned to the specified Tray Holder, typically a Stack or Agitator uses a Path.
Wash Stations	The Wash Station and its positions “Wash1” and “Wash2” are visible and selectable. Details , see below.
Injectors	The Firmware Objects accessed on the PAL Extended User Mode have more specific items selectable than at the User level. Tolerances or ranges such as “Maximum Penetration” can be defined and limited for the user so that this value cannot be exceeded. In the “Tray Types” Object, details for the various Items are described. Furthermore, in this Firmware Object class a “Valve” and/or a “Heater” can be assigned. Note that the Wash Station Positions “Waste” and “Waste2” are listed in this “Injectors” class.
Valves	The Valves and Valve Drives connected and controlled by an “AUX” interface are listed in this Object class. For more details, see the Valves and Valve Drives Addendum. Note that the valves controlled by serial communication (Serial Valves or Multiposition Valves) are in the PAL Firmware Object class “Serial Valves”.

Agitators	At this level items such as "Motor Drive", " Minimum Speed " and "Maximum Speed" are selectable for the "Agitator" Object. The range can be set for the speed. The other items are available directly as Method parameters.
Dilutors	The Firmware Objects accessed in the PAL Extended User Mode have more specific items selectable than at the User level. Tolerances or ranges such as " Maximum Fill Speed " can be defined and limited for the user so that this value cannot be exceeded. Items such as " Prime Volume ", " Waste to ", " Motor Drives ", or " Scale Length " are specific items that remain hidden at the User level.
Tools	The Object class " Tools " is used to handle another device, such as the MHE-Tool (Multiple Headspace Extraction Tool) or MALDI Tool . For details, see the specific Addendum for the PAL User Manual.
Positions	The various positions used with the PAL System are selectable at this level. Positions such as " Home ", " Change Syringe ", or a Path Point, reference the Paths for a specified Tray Holder directly, such as " Agitator " or " Stack ". Selecting an item, e.g. " Home " will provide the function key " F1 ", Check Pos " on the screen. Activating this function provides the possibility of verifying X-, Y-, Z-axes values for this particular position.
Paths	A Path defines specific movements for the Injection Unit, which represent a repetitive task assigned to a Tray Holder. Typical examples are opening and closing a drawer from a Stack or opening the lid of an Agitator. The Path is composed of several steps (points) which are added up in a sequence. Each individual step (point) can be positioned by teaching X-, Y-, Z-axes. In most cases the return path is in the reverse order of the starting path. Example " AgiOpnL " and " AgiClsL ". If one setting of a point is changed, this change will be valid for the return path as well.
Sync Signals	The various synchronization signals are described above in Section F. "Description and Installation", point 6.1. At this level no other functionality, as shown at the user level, is provided.
Out Signals	The various Out-Signals are described above in Section F. "Description and Installation", point 6.1. At this level no other functionality, as shown at the user level, is provided.
Events	The various synchronization signals are described above in Section F. "Description and Installation", point 6.1. At this level no other functionality, as shown at the user level, is provided. Three events are newly available at this extended user level: Pwr-Out1 , Pwr-Out2 and FlushVlv . The main purpose of these three power-out signals is to activate a solenoid, such as for the Wash Station or the Gas Flush Valve. At this level the functionality of the signal can be tested.
Serial Valves	Serial valves, or "Multiposition Valve Drives" are powered and controlled by the serial (RS232) control and not through the "AUX" interface. With firmware version 4.1.X a " Mode " is now selectable. The mode refers to the setting of the Valve Drive, whether the current for the motor is set to " High Speed " or " High Torque ". For more details, see Addendum to PAL User Manual "Valve and Valve Drive".
Out Exp Box	The "Out Expansion Box" provides 8 TTL contacts and 8 relay contacts (24 V contact closure). The optional module (box) is connected and controlled by "Interface 2". For more details, see Out Expansion Box Addendum to PAL User Manual.
RS232	This Object allows selecting the serial ports for the specific needs. Choices are: Remote, Terminal, Printer, Barcode, ExtDev, VICI-Vlv (for serial valve drives), or None.

Motors

In the class '**Motors**', the Objects '**Motor-Y**' and '**Motor-Z**' are accessible, to enable the user to select specific motor parameters in case a specific application requires an adjustment.

Motor-Y

Strategy

Three different settings are selectable for the Y-Motor movement strategy:

Rectang = normal movement as used for PAL system.

(In firmware version < 4.1.X. this mode was called "Auto".)

XY-Simul = X,-Y-axes move simultaneously, which allows movement in a diagonal direction. Do not use this mode for routine work.

(At firmware version < 4.1.X this mode was called "Rectang", but it was not active at lower versions.)

Retract = Y-axis moves from any point first to zero Y (back to the X-axis) before the X-movement is started. This mode allows bypassing an object (such as a large GC detector) which may be in the travel path if the default mode "Rectang" is used.

Path Speed = Y-axis motor speed in conjunction with a "Path", example: Opening and closing a drawer of a Stack. In certain situations it is necessary to slow down the speed to open and close a drawer. Typical application example is fraction collection, collecting directly into a well plate. If the liquid level is high, the liquid can wash over into the next row if drawer movement is too fast.

Remark: At PAL Firmware version 4.1.X these items of the Y motor have been made available at the Extended User Level.

Motor-Z

For the 'Motor-Z', following speeds are selectable:

Penetr Speed = This is the speed used to penetrate the syringe needle into any object, with the exception of the injector. Example: Vial penetration.

Inj Penet Spd = Injector Penetration Speed. With PAL Firmware version 2.X and 3.0 the injector penetration speed is identical to the injector retraction speed.

Inj Retr Spd = Injector Retract Speed. With PAL Firmware version 4.1.X, the injector speed was separated into a penetration and a retraction speed. This allows safe penetration of a vial by any type and diameter of syringe needle without bending through the septum of the GC injector. The needle retraction speed can be increased to speed up the entire injection process. This new feature enables the user to avoid uncontrolled evaporation of any remaining sample solution in the needle.

The visibility of the Motor-Z parameters at the Extended User Level was introduced with PAL Firmware version 4.1.3.

Items displayed in "*italic*" are available beginning at PAL Firmware Version 4.1.X.
Items displayed in "**bold**" are explained in detail below.

10.3.1. Tray Type

The following object "Tray Type" Items may be changed by selecting the particular item. First select the desired **Tray Type**, such as "VT32-20".

note

The definition of Row and Column is given above in Section F. "Description and Installation, point 4.2.3.1.

By reversing the first six entries, the order of injection can be changed.

Example: Tray Type "VT32-20" has a "Row Length Y" and a "Col Length X" defined. Reversing to "Row Length X" and "Col Length Y" would start with sampling from left to right, as used e.g. with Tray Type "DW96".

The values of the items "Spl Per Row" and "Spl Per Col" must also be reversed.

Item	Description
Row Length X	Defines the Row length in the X-direction from the center of the first to the center of the last vial position, measured in mm.
Row Length Y	Defines the Row length in the Y-direction from the center of the first to the center of the last vial position, measured in mm.
Col Length X	Defines the Column length in the X-direction from the center of the first to the center of the last vial position, measured in mm.
Col Length Y	Defines the Column length in the Y-direction from the center of the first to the center of the last vial position, measured in mm.
Spl Per Row	Number of samples per Row.
Spl Per Col	Number of samples per Column
Pattern	The pattern of the Row or Column arrangement has to be defined. Regular = square arrangement (standard) Staggrd+ = Rows are arranged in staggered pattern. Offset of second Row is shifted by +50% of hole pattern. Staggrd- = Rows are arranged in staggered pattern. Offset of second Row is shifted by -50% of hole pattern. See Graphics below.
TrayTypeGroup	Software protection so that not every Tray Type can be placed on any Tray Holder. Example: VT32-20 cannot be fit into a Stack.
Plate Thickn	Thickness of Tray plate bottom (not the total height of the Tray). Measured in mm.
Vial Height	Total height of the vial including cap to seal if applicable. Measured in mm. Remark: The sum of the plate thickness and vial height adds up to the total height This is the point where the Injection Unit expects an object.
Vial Tmsprt	The mode to transport a vial is defined by: None = No transport required. Example liquid sampling. Magnet = Magnetic Transport. Requires magnetic vial caps. The Injection Unit moves to the side to slide the vial off when moved away. Needle = Device is transported with the syringe needle inserted. Example: special vials where a magnetic cap cannot be crimped, e.g. "Vacutainer". Remark: This item became active beginning at PAL Firmware version 2.5.X.
ZSlideOffRetr	If magnetic transport is selected, the distance can be defined to move the syringe slider up (Z-direction), lifting up the vial by magnetic force. Measured in mm.
YSlideOffDist	If magnetic transport is selected, the distance can be defined to move the Injection Unit to the side, Y-direction, to slide the vial off. Measured in mm.
Barcode	If a Barcode Reader is installed, the mode has to be set for "AutoFix". None = No Barcode Reader option requested for this Tray Type.

Z Tolerance	A tolerance window to give a plus/minus range (expressed in mm) where the Injection Unit must expect an object. If the value of this item is > 0, this is a relative detection mode and the sensor from the Injection Unit needle guide is active. If the value of this item is set to "0" the sensor of the needle guide is turned off and the syringe slider moves to an absolute value, Z-axis position as specified in the object.
Z Retract	The distance to lift up the syringe slider before the Y-, Z-axes assembly moves across the unit can be specified, expressed in mm.
Max Penetr	The maximum allowed Needle Penetration can be defined as a safety so that the user cannot destroy the needle tip by going too far down. The Tray Type is prepared for a specific vial size; this value is therefore unique to this combination. The maximum needle penetration must not exceed the length of the syringe needle, considering the loss due to needle guide, etc.. Typical needle length is 51 mm, maximum penetration must not exceed 48 mm.
Needle Penetr	This item is identical to that used on the User Level or, if available, as a method parameter of a local cycle. The value defined on these levels is mirrored to the Extended User Level.
Spl1 Offset X	The "X" offset is defined as the distance from the outer edge of the Tray in the X-direction to the center of the vial position 1. Measured in mm.
Spl1 Offset Y	The "Y" offset is defined as the distance from the outer edge of the Tray in Y-direction to the center of the vial position 1. Measured in mm.
Spl1 Offset Z	The "Z" offset can be selected for special cases where, e.g. the syringe needle has to reach a deeper point before penetration into a vial. A "Z" offset value = 0 considers the Tray surface or vial top as the reference point. Measured in mm.

Items displayed in "*italic*" are available beginning with PAL Firmware Version 4.1.X.

note

The dimensions used for Row/Column Length or X-, Y-, Z-Offsets for Sample Number 1, are specific for a particular Tray Type. If a general adjustment for a Tray from a specific vendor – e.g. for a Deepwell Plate – has to be made, this should be done in the "Tray Type" class of Object. For fine tuning, the Offset items from the class "Trays" can be used.

Explanation for various Patterns in Tray Type:

1. Pattern Type "Regular".
The sample or well positions are equal distributed.

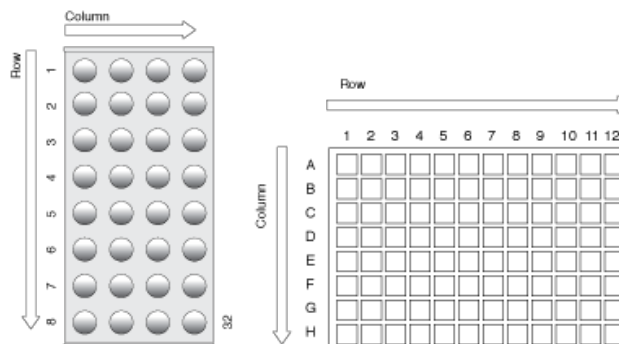


Figure 53. Pattern Tray Type "Regular"

2. Pattern Type "Staggrd+."
The sample or well positions are arranged in a staggered pattern.
Offset of second Row is shifted by + 50% of hole pattern.

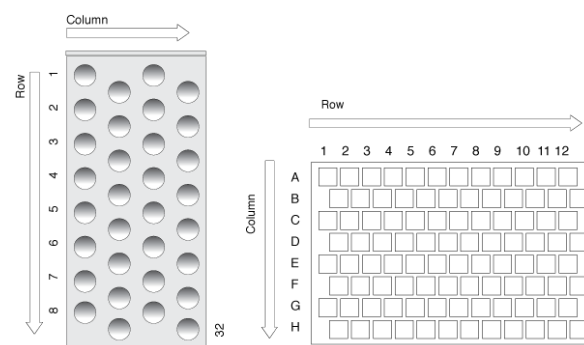


Figure 54. Pattern Tray Type "Staggered+"

3. Pattern Type "Staggrd-".
The sample or well positions are arranged in a staggered pattern.
Offset of second Row is shifted by - 50% of hole pattern.

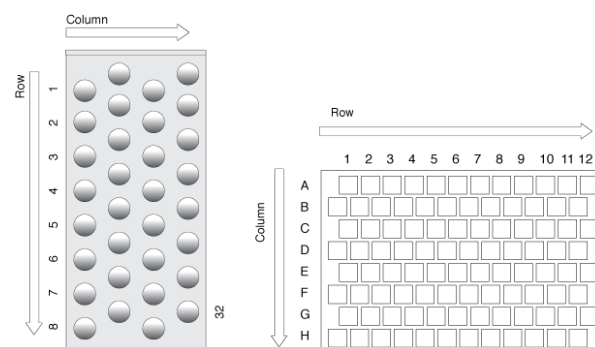


Figure 55. Pattern Tray Type "Staggered-"

10.3.2. Trays

The following object “**Tray**” Items can be changed by selecting the particular item. First select the desired Tray, such as “**Tray1**”.

Item	Description
Tray Holder	The Tray Holder to which the Tray is assigned is specified.
TrayTypeGroup	All Tray Type Groups which are allowed for this particular combination of Tray and Tray Holder are displayed. The “TrayTypeGroup” for the Tray Type itself is specified for each Tray Type.
Tray Type	The Tray Type to be used is linked to the Tray. This item is usually set at User Level in “Utilities/Trays”. See above.
Offset X	The “X” offset is defined as the distance from the center of the teaching position from the Tray Holder to the edge of the Tray in X-direction. Measured in mm. This item is available at User level in section “Utilities/Tray” and can be used for fine tuning a Tray installed in a Tray Holder. Important for well-plates 384 installed in a Stack. Remark: Position#1 is the only correction point.
Offset Y	The “Y” offset is defined as the distance from the center of the teaching position from the Tray Holder to the edge of the Tray in Y-direction. Measured in mm. This item is available at User level in section “Utilities/Tray” and can be used for fine tuning a Tray installed in a Tray Holder. Important for well-plates 384 installed in a Stack. Remark: Position#1 is the only correction point.
Offset Z	The “Z” offset is defined as the distance from the plate surface of the Tray Holder to the teaching point, black needle guide flush underneath plate of Tray Holder (which corresponds to plate thickness of Tray Holder). Measured in mm. This item is available at User level in section “Utilities/Tray” and can be used for fine tuning a Tray installed in a Tray Holder. Important for well-plates 384 installed in a Stack. Remark: Position#1 is the only correction point.
Path Offset X	The Path Offset “X” can be specific for a Tray, adjustment in X-direction. Expressed in mm. Remark: This item is only valid if a Path is assigned to the Tray Holder as specified in this combination.
Path Offset Y	The Path Offset “Y” can be specific for a Tray, adjustment in Y-direction. Expressed in mm. Remark: This item is only valid if a Path is assigned to the Tray Holder as specified in this combination.
Path Offset Z	The Path Offset “Z” can be specific for a Tray, adjustment in Z-direction. Expressed in mm. Remark: This item is only valid if a Path is assigned to the Tray Holder as specified in this combination.
<i>dxRow</i>	Correction for inclination of a Tray in X-row direction. For details, see Section 4.2.3.2 above.
<i>dyRow</i>	Correction for inclination of a Tray in Y-row direction. For details, see Section 4.2.3.2 above.
<i>dzRow</i>	Correction for inclination of a Tray in Z-row direction. For details, see Section F. “Description and Installation”, point 4.2.3.2 above.
<i>dxCol</i>	Correction for inclination of a Tray in X-column direction. For details, see Section F. “Description and Installation”, point 4.2.3.2 above.
<i>dyCol</i>	Correction for inclination of a Tray in Y-column direction. For details, see Section F. “Description and Installation”, point 4.2.3.2 above.
<i>dzCol</i>	Correction for inclination of a Tray in Z-column direction. For details, see Section F. “Description and Installation”, point 4.2.3.2 above.

Items displayed in “*italic*” are available beginning with PAL Firmware Version 4.1.X.

10.3.3. Wash Stations

The following object “Wash Station” items may be changed by selecting the particular item. First select the desired Wash Station, such as “**Wash1**”.

Item	Description
Position X	X-axis position for Wash Station.
Position Y	Y-axis position for Wash Station.
Position Z	Z-axis position for Wash Station.
Z Tolerance	A tolerance window for a plus/minus range (expressed in mm) where the Injection Unit has to expect an object. If the value of this item is > 0, this is a relative detection mode and the sensor from the Injection Unit needle guide is active. If the value of this item is set to “0” the sensor of the needle guide is turned off and the syringe slider moves to an absolute value, Z-axis position as specified in the object.
Z Retract	The distance to lift up the syringe slider before the Y-, Z-axes assembly moves across the unit can be specified, expressed in mm.
Max Penetrat	The maximum allowed Needle Penetration can be defined as a safety so that the user cannot destroy the needle tip by going too far down. The maximum needle penetration must not exceed the length of the syringe needle, considering the loss due to needle guide, etc.. Typical needle length is 51 mm, maximum penetration must not exceed 48 mm.
Needle Penetr	This item is identical to that at the User level. The value defined at this level is mirrored to the Extended User Level.
Type	The specific mode for the Wash station in use has to be defined: Standard = Standard Wash Station. Syringe is filled with wash solvent and expelled into Waste. Pulse = A pulsed signal is sent to activate the device. Used for the “Fast Wash Station” and “Active Wash Station”. See Type ‘Active’ for details. Flow = Continuous flow of liquid by gravity. No electrical contact required for a solenoid. DLW = Dynamic Load & Wash. Item used to activate specific solenoid for DLW Wash Station. Active = Used for Active Wash Station in conjunction with the Wash Station Print with PNo. ‘APR WASHPUMP B.A.’ (Revision B). Simplified print, activation of pumps is controlled by PAL Firmware. Requires Object Lists ‘PAL WashActive_Rev. B’. Remark: Type ‘Active’ is not used for Fast Wash Station operation and cannot be used for first generation Active Wash Station with print Revision A installed. For these cases is the type ‘Pulse’ required.
Flow Control	The power source to activate a Wash Station is specified. For the Fast, Active Wash Station and DLW the Event “Power-Out1” and “Power-Out2” is used.
Ndl Cln Path	A Path can be assigned to the Wash Station.
Waste to	The Waste position is assigned to the Wash Station.
Clean Volume	A percentage of the syringe maximum volume is defined for the cleaning step.
Clean Count	The counter monitors the number of wash cycles. The setting in the method has the same functionality and the value is mirrored to the Extended User Level.
Max Fill Spd	The fill speed for the syringe is defined with this item. If the maximum value of the Fill Speed (10.0 mL/s) is selected, the system takes the injection syringe Fill Speed as defined in the method.
Max Eject Spd	The Eject Speed is the speed used to eject the wash solvent during the wash cycle. This speed is usually higher than the Fill Speed. If the maximum value of the Eject Speed (10.0 mL/s) is selected, the system takes the injection syringe Eject Speed as defined in the object class “Syringe”.
Rinse Time	Rinse is the time to rinse the wash port with wash solvent after the wash cycle of the syringe has been finished. In the case of Fast/Active Wash Station, the syringe needle is pulled out of the wash port. The wash solvent flows without restriction. As a result, higher solvent consumption has to be taken into consideration.

Items displayed in “*italic*” are available beginning with PAL Firmware Version 4.1.X.

G. Troubleshooting PAL and PAL-*xt* System

note

*The HTS PAL always represents one of several total components in a chromatography system. The following Troubleshooting Guide is limited to the HTS PAL or PAL-*xt* only.*

Symptom or Error Message	Possible Cause	Recommended Action
No or very low detector signal is observed.	Clogged syringe.	Remove syringe and aspirate/dispense liquid manually. Clean syringe.
	Bent needle.	Inspect and/or change syringe.
	No sample liquid is injected.	Check and/or adjust Needle Penetration into sample vial (see section F, point 6.2.).
	Sample volume too low.	Increase sample volume.
	The valve needle guide and/or needle seal are not properly installed.	Check valve needle guide and seal (see section F, point 6.2.5.).
	The valve ports are not plumbed correctly to the pump and/or detection system.	Check plumbing connections (see section F, point 6.2.).
	Wrong valve type specified.	Check valve type by selecting path: Menu/setup/Objects/Injectors/LCVlv1/valve.
Mobile phase and/or sample flows out of the wrong ports on LC injection valve.	The valve rotor is reversed (180 ° out of alignment).	Remove the rotor and reinstall in the correct position. In case of a Cheminert valve, check for marking points. In case of a W-type valve look for a letter (e.g. "H") stamped on the rotor. The letter must be on the lower half of the rotor. See section F, point 6.2.).
Sample is backing up on the valve needle guide.	Syringe OD too small.	Check the syringe needle for correct Gauge. Gauge 22 = OD 0.72 mm Gauge 19 = OD 1.06 mm
	Valve needle seal leaks.	Change valve needle seal, see section F. point 6.2.5.)
	The needle penetration depth for the injection valve is not set correctly.	Adjust the Injection Valve Needle Penetration (see section F, point 6.2.6.).
	The syringe Plunger speed is too high resulting in excessive pressure in inlet.	Reduce Inject Speed in method.
Syringe does not fill properly.	Air bubbles below Syringe plunger. Air bubbles may remain below the plunger after the first pull up. If the plunger is moved up and down several times, these air bubbles are worked out.	Increase method parameter "Fill Strokes". Check syringe parameter "Eject Speed".
Sample peaks or responses are not reproducible.	Dirty syringe.	Increase Pst Cln Slv1/Slv2 values in method. Use PreClnSlv1/Slv2 and PreClnSpl.
	Syringe pressure differences.	Increase Pullup Delay value.
	Vacuum created in sample vial.	Reduce sample volume in sample vial. Use setting under "F3-Setup/System/PrePressureVial".
	Method Parameters	Check recommended Method Parameters in Flow Chart "Firmware Overview", Appendices, point 4. The following parameters are crucial and should be verified first: - Fill speed - Pullup delay - Injection Speed - Post Inj Delay

Peak distortion or tailing.	Method Parameters.	See recommended actions above.
	Solvent for analytical solution not suitable.	Change solvent composition to a lower polarity 8incase of reversed phase chromatography).
	Tubing internal diameter	Check tubing internal diameters for connection tubings and injection loop. See recommendations as given with poster 'Tips&Hints for HPLC Technique' (CTC Analytics).
	Bad connections	Connection tubing's not square cut or wrong type of nuts/ferrules installed. See recommendations as given with poster 'Tips&Hints for HPLC Technique' (CTC Analytics).
	HPLC related problems	Any parameter like flow rate, composition of mobile phase or wash solvent, column selection (diameter, pore size, etc.) can contribute to BAD PEAK SHAPE. Ched troubleshooting guide from the HPLC manufacturer or any other source.
Excessive carryover between samples.	Dirty syringe and/or valve injection port.	Increase Pst Inj Slv1/Slv2 values in method. Use PreClnSlv1/Slv2 and PreClnSpl.
	Inappropriate wash solvent(s).	Use appropriate wash solvent(s).
	Waste tubing ID at injection valve is too small, causing waste liquid to be pulled back, by capillary action, into rotor groove.	Replace the waste tubing with larger ID tubing.
	Damaged or grooved valve rotor.	Replace valve rotor, see section H, point 4.
	Valve needle seal leaks.	Change valve needle seal, see section F, point 6.2.5.
	Inappropriate wash solvent composition.	Use appropriate wash solvent. Observe also the order of use for biological samples. First wash is always an aqueous solution followed by organic solvents.
Unexplained collisions of the Injection Unit.	Object(s) not defined correctly.	Define Object(s) correctly. (See section F. "Describing and Installing", point 4.1.)
Error Message "Object Not Detected".	Incorrect Z value for the affected Object (e.g. LCVlv1, THldr1 or CStk1-01).	Redefine Z value for the affected Object. (See section F. "Describing and Installing", point 4.1.)
	Missing sample vial, Deepwell- or Microtiter plate.	Check position and insert, if necessary, vial, deepwell- or microtiter plate.
Error Message "Object collision before Z Tolerance" ("Object" e.g. Tray1, LCVlv1, CStk1-01).	Incorrect Z value for the affected object.	Redefine value for the affected object. (See section F, point 4.1.)
Error Message "Invalid Motor Status Motor AUX1". (AUX2)	Injection valve not connected.	Switch OFF PAL and check connection between PAL and Valve Drive.
	Defective LCVlv Connection cable.	Change connection cable.
	MOTIO Board defective.	Replace MOTIO or Control- <i>xt</i> Board.

H. Replacing Parts

note*Safety Warning*

Always disconnect the power cord(s) from the power supply or from the various power supplies if optional devices are installed before attempting any type of maintenance.

Capacitors inside the instrument may still remain charged even if the instrument is turned off.

To avoid damaging electrical parts, do not disconnect an electrical assembly while power is applied to the PAL system. Once the power is turned Off, wait approximately 30 seconds before you disconnect an assembly.

1. MOTIO Board

PNo.: APR Motio

1. Follow the sequence shown in Figure 56 to detach and release the MOTIO board from its position inside the X-axis.
As shown, remove the dummy cover first.
Slide the MOTIO board to the left side. This is necessary because the board mates on its right side with the connector on the CPU board;
2. Carefully pull the two ribbon cable connectors upwards to free them from the board;
3. Install the replacement board in the reverse order.

note

After reconnecting the two ribbon cables to the board, ensure that the cables are folded flat and can slide inside the X-axis without damage.

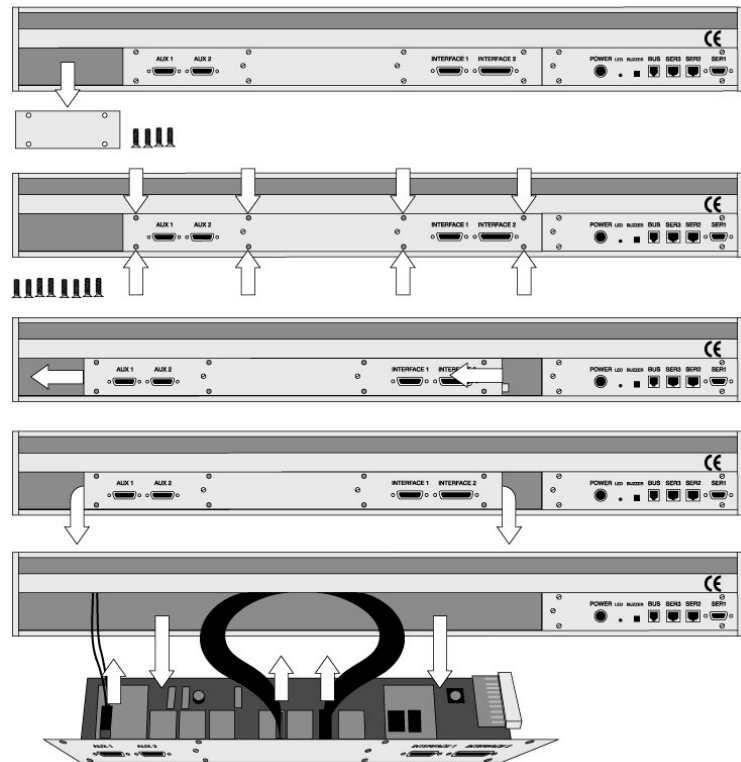


Figure 56. Replacing MOTIO Board

2. CPU Board

PNo.: APR CPU

1. Remove the right end cover of the X-axis (facing the rear of the chassis).
Remark: This step is only necessary if the CPU board needs to be removed and the MOTIO Board remains in the system;
2. Slide the CPU board out and towards the right end of the X-axis. This is necessary because the CPU board mates on its left side with a connector on the MOTIO board;
3. Install the replacement board in the reverse order.

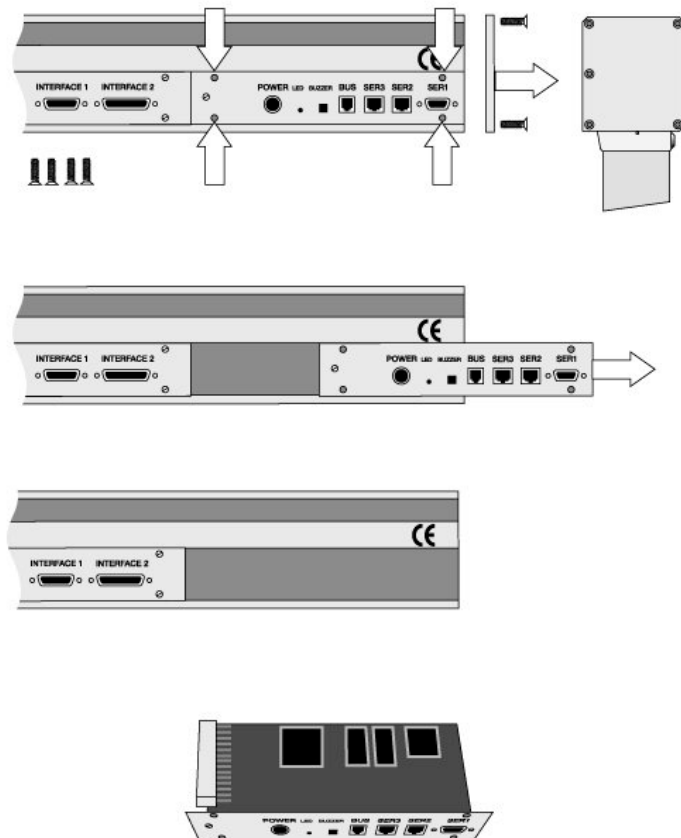


Figure 57. Replacing CPU Board

3. Control-*xt* Board

PNo.: APR Control-*xt*

note

The Control-*xt* board combines the MOTIO and the CPU boards in a single control board.

This board is required for the PAL HTS-*xt* System and operates only at PAL Firmware version 4.1.X or higher.

1. Follow the sequence shown in Figure 58 to detach and release the Control-*xt* board from its position inside the X-axis.
As shown, remove the dummy cover first;
2. Carefully pull the two ribbon cable connectors upwards to free them from the board;
3. Install the replacement board in the reverse order.

note

After reconnecting the two ribbon cables to the board, ensure that the cables are folded flat and can slide inside the X-axis without damage.

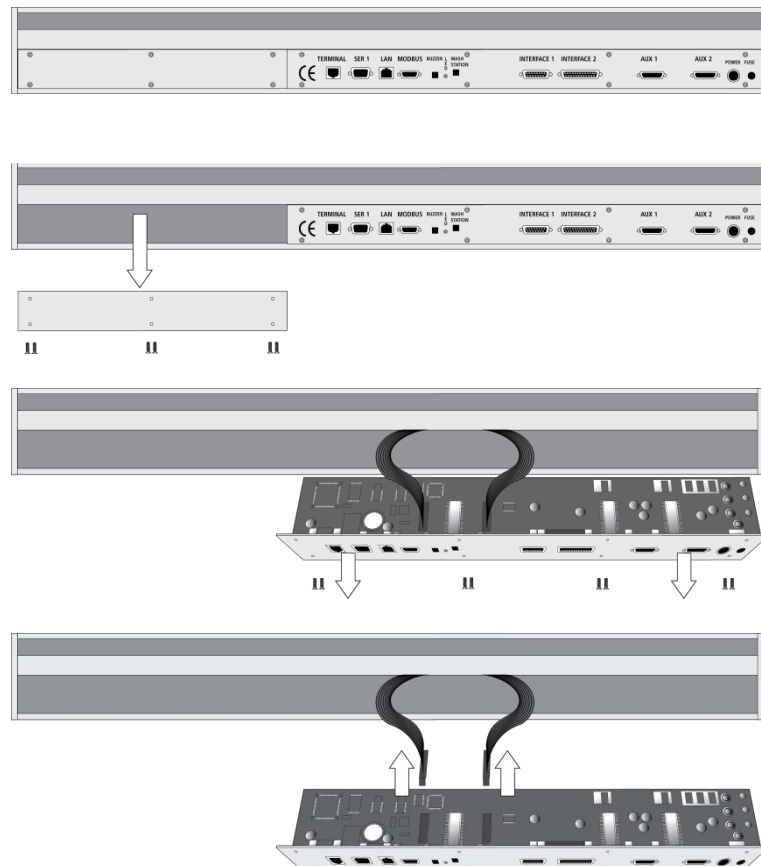


Figure 58. Replacing Control-*xt* Board

4. Injection Valve and Valve Rotor

note

In this section the commonly used injection valves with 6-ports are described. For more details or information on other valve types, such as a 10 port valve, see Addendum to PAL User Manual "Valve drives and Valves".

4.1. Injection Valve

4.1.1. Cheminert Type Valve

To replace and/or clean the injection valve, Cheminert type, follow the steps shown in Figure 59.

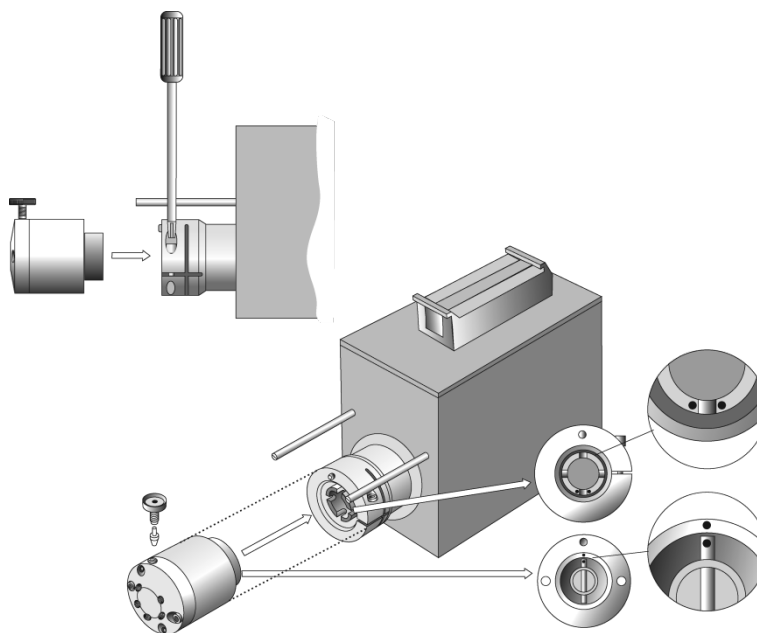


Figure 59. Replacing the Injection Valve VICI/Valco Cheminert Type

1. Remove the sample loop, needle guide fitting and connection tubes from the valve body;
2. Unscrew the Torx screw at the valve adapter, which holds the valve to the valve drive;
3. Check that the valve guide pin remains at its position and observe the guide marks as shown in Figure 59;
4. Install the replacement valve in the reverse order.

4.1.2. W-Type Valve.

To replace and/or clean the injection valve, W type, follow the steps shown in Figure 60.

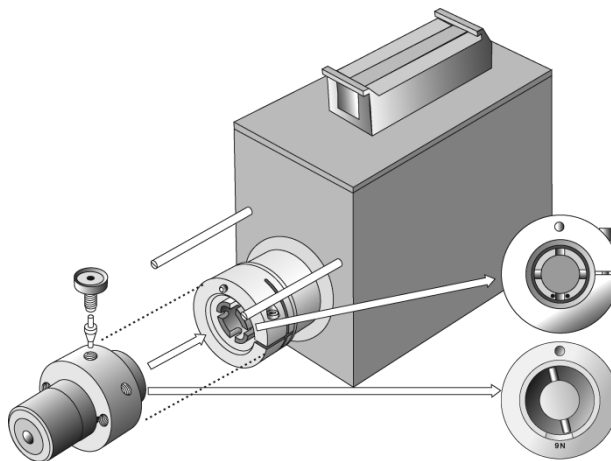


Figure 60. Replacing the Injection Valve Valco W-Type

1. Remove the sample loop, needle guide fitting and connection tubes from the valve body;
2. Unscrew the Torx screw at the valve adapter, which holds the valve to the valve drive;
3. Check that the valve guide pin remains at its position;
A guiding mark is not stamped in, in doubt check the orientation of the rotor as shown below in Figure 64;
4. Install the replacement valve in the reverse order.

4.1.3. Rheodyne Valve PD7991 (Diameter Valve Pod: 27 mm)

To replace and/or clean the injection valve, Rheodyne PD7991 type, follow the steps shown in Figure 61.

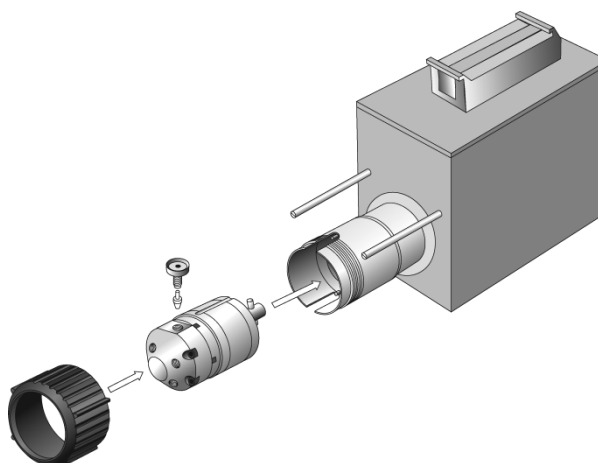


Figure 61. Replacing the Injection Valve Rheodyne PD7991

1. Remove the sample loop, needle guide fitting and connection tubes from the valve body;
2. Unscrew the threaded plastic sleeve at the valve adapter, which holds the valve to the valve drive. Pull out the valve body from the drive sleeve;
3. Check that the valve guide pin remains at its position; Observe the correct orientation of the guiding pin as shown below in Figure 65 and Figure 66 for the Valve Drive position;
4. Install the replacement valve in the reverse order.

4.1.4. Rheodyne Valve PD718-313 (Diameter Valve Pod: 32 mm)

To replace and/or clean the injection valve, Rheodyne PD718-313 type, follow the steps shown in Figure 62.

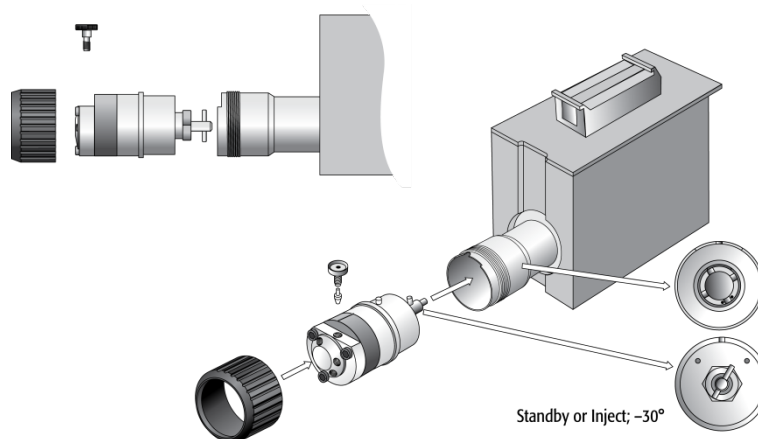


Figure 62. Replacing the Injection Valve Rheodyne PD718-313

1. Remove the sample loop, needle guide fitting and connection tubes from the valve body;
2. Unscrew the threaded plastic sleeve at the valve adapter, which holds the valve to the valve drive. Pull out the valve body from the drive sleeve;
3. Check that the valve guide pin remains at its position; Observe the correct orientation of the guiding pin as shown below in Figure 67 and Figure 68 for the Valve Drive position;
4. Install the replacement valve in the reverse order.

4.2. Replacing Valve Rotor

4.2.1. Cheminert Valve

To replace and/or clean the valve rotor of a VICI/Valco Cheminert type valve, follow the steps shown in Figure 63.

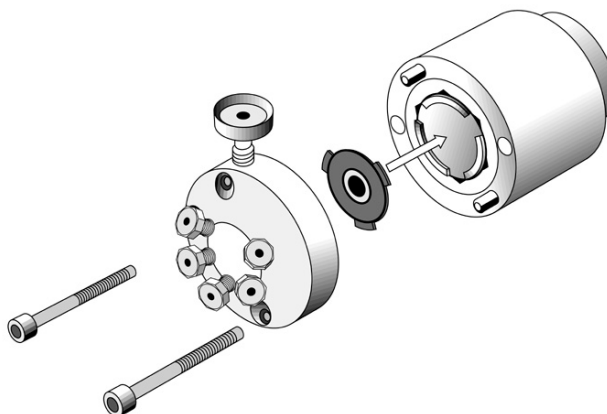


Figure 63. Rotor Replacement of Cheminert Valve Type

1. Do not remove the valve from the valve drive. For reasons of improved access, all tubing or the loop may be removed;
2. Unscrew the two hex screws which hold valve stator to the valve body;
3. Lift out the rotor disk carefully with a protected tool (tips protected to avoid scratching the surface);
4. Insert the new rotor. The positioning tabs are size coded. Insertion upside down is not possible;
5. Tighten the hex screws carefully and evenly to reach a parallel seat of valve stator and body.

4.2.2. Replacing W-Type Valve Rotor

To replace and/or clean the valve rotor of a Valco W-type valve, follow the steps shown in Figure 64.

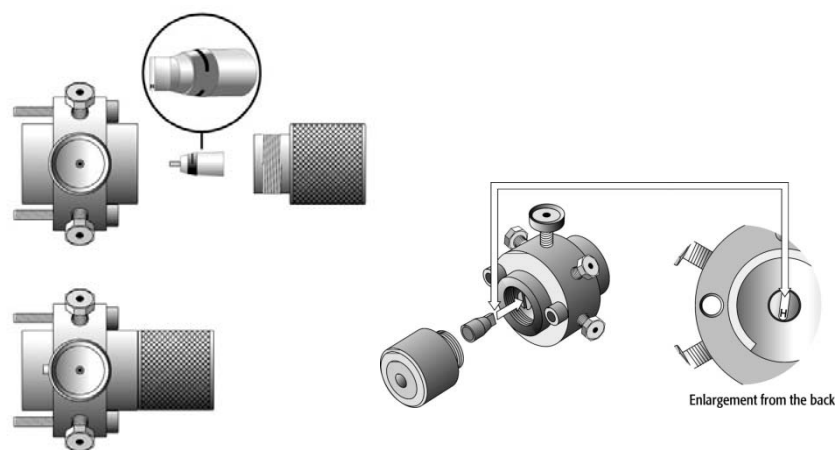


Figure 64. Rotor Replacement of W-Type Valve

1. Do not remove the valve from the valve drive. For reasons of improved access, all tubing or the loop may be removed;
2. Unscrew the knurled pre-load assembly. Do not tamper with the preset socket adjustment screw;
3. Engage the end of the rotor with a magnet or a pair of tweezers (tips protected to avoid scratching the surface);
4. Locate the letter (e.g. "H") stamped on the new or cleaned rotor and orient the letter to the lower half of the valve;
5. Insert the new or cleaned rotor. Make sure the rotor tab fits into the slot in the valve drive;
6. Replace the knurled pre-load assembly;
7. Tighten the pre-load assembly. It must end up fully bottomed-out.

4.2.3. Replacing Rheodyne PD7991-Type Valve Rotor

To replace and/or clean the valve rotor of a Rheodyne PD7991-type valve, follow the steps shown in Figure 61.

note

The Rheodyne Valve PD7991 can be maintained in a similar way as the Cheminert valve type. Replacing the rotor has to be done carefully, as it is possible to insert it incorrectly, upside down. Below, the correct orientation of the Rotor guide pin is illustrated.

Rotor position, view from backside of valve body, actuator side:

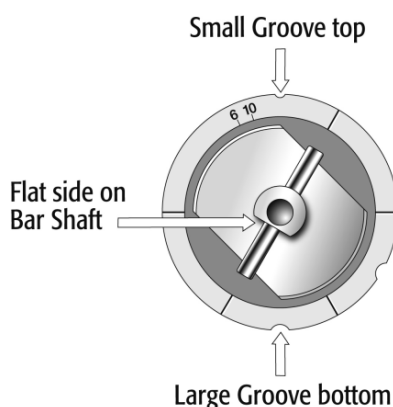


Figure 65. Rheodyne Valve PD7991, Rotor Position

Valve Drive position in "Home" or "Standby" position:

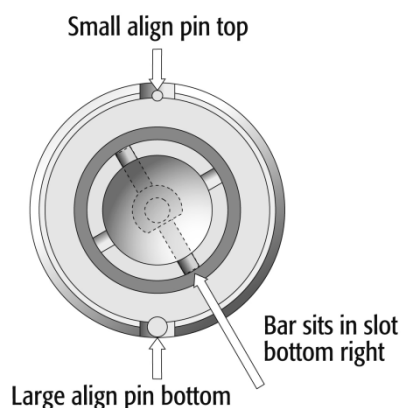


Figure 66. Valve Drive Settings for Rheodyne Valve PD7991

4.2.4. Replacing Rheodyne PD718-313-Type Valve Rotor

To replace and/or clean the valve rotor of a Rheodyne PD718-313-type valve, follow the steps shown in Figure 62.

note

The Rheodyne Valve PD718-313 can be maintained in a similar way as the Cheminert valve type. Replacing the rotor has to be done carefully, as it is possible to insert it incorrectly, upside down. Below, the correct orientation of the Rotor guide pin is illustrated.

Rotor position, view from backside of valve body, actuator side:

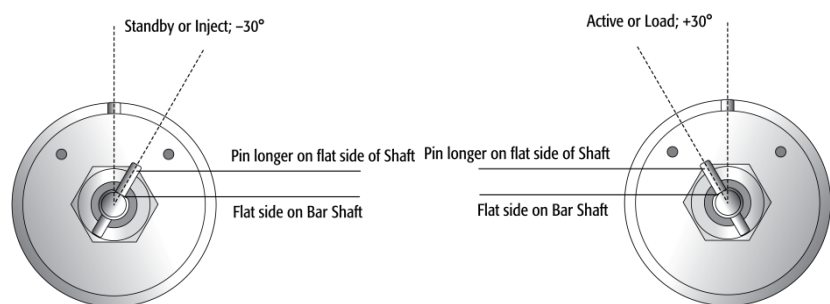


Figure 67. Valve Position 'Standby' and 'Active'. PD718-313

Valve drive Actuator, View from front of Actuator



Figure 68. Actuator Position 'Standby' and 'Active', PD718-313

5. Injection Unit

Follow the sequence of steps shown in section F. "Description and Installation", point 3.2, "Assembling the HTS PAL".

6. Wash Station

Follow the sequence of steps shown in section F. "Description and Installation", point 3.2, "Assembling the HTS PAL".

I. Maintaining the PAL System

Regularly performing maintenance helps ensure accuracy and precision of the PAL System. Suggested intervals for maintenance procedures are given below to ensure uninterrupted operation.

If you use the system extensively (for example, nights and weekends), or if you use corrosive solvents, you may need to perform the maintenance procedure more frequently.

Maintenance Step	Interval
Clean the outside of the instrument. Use only a soft lint-free cloth dampened with mild soap and water.	Weekly or as needed
Clean Instrument, syringe and surfaces	Weekly or as needed.
Replace the syringe plunger	Syringe Plunger for a gas tight syringe (polymer tip) has to be replaced on a regular basis. The interval is highly dependent on the application, throughput, quality of sample solution (particles, etc.) washing solvent. It is advisable to check the tightness of the plunger on a regular basis to gain experience with the application.
Replace the Valve Needle Seal	Check the tightness of the needle in the needle seal. See section F, point 6.2.5.
Replace the Valve Rotor	Annually or more often, depending on the throughput and quality of sample solution and mobile phase.
Wash and Waste Solvent reservoirs	Weekly or as needed. Replace the Septum as well to avoid carry-over.

The other steps are described in the "Preventative Maintenance Procedure". Specific kits for the GC or the HPLC techniques are available. The kits include the parts which must be changed annually.

The Kit PMKitDLW includes all parts from the PM Kit1 but additionally the specific parts for the PAL DLW Option.

- PNo.: PAL PM Kit1; Description: PM Kit for HPLC technique
- PNo.: PAL PMKitDLW;
Description: PM Kit for HPLC Systems including PAL DLW Option.
- PNo.: PAL PM Kit2; Description: PM for GC technique.

Contact your CTC Analytics representative to perform an annual preventative maintenance on the PAL System.

note

There are no operator-serviceable or replaceable parts inside the power supply(ies) or the PAL System. In case of a failure, contact a representative of CTC Analytics.

J. Appendices

1. Definition of Terms

Job Queue

A Job Queue is a list of sample processing Jobs. Jobs are executed in the order displayed on the JOB QUEUE menu screens. New Jobs may be added to the queue while samples are being processed.

Job

A Job contains the information needed by the PAL to process multiple samples by the same processing steps. The elements of a Job are a Method and a Tray that define the location of the samples to be processed. For identification, Jobs are automatically numbered from 01 to 99 and then restarting with 01 when they are added to the Job Queue.

Cycle

A Cycle consists of the specific operations necessary to process one sample. The Cycle operations are repeated for each sample within a Job. Cycles are designed for specific applications.

Method

A Method defines how the samples are processed. The elements of a Method are a Cycle, a Syringe and a Parameter List. Methods have names with up to eight characters and can be edited, copied, and deleted.

Method Parameters

Method Parameters are associated with the Cycle operations. User-assigned Parameter values define how a processing operation is performed. A zero Parameter value will disable a Cycle operation. Cycle Parameters are application-specific.

Tray Holder

A Tray Holder can hold one or more trays. Each Tray Holder has a reference position (X-, Y-, Z-coordinates) that defines its location.

Tray

A Tray holds multiple samples. Trays are defined by designating the Tray Type (see below) and the Tray Holder. Tray names are used to identify the sample source within a PAL Job.

Tray Type

A Tray Type defines the pattern and sampling sequence of sample locations within a Tray.

Stack

A Stack is a particular type of Tray Holder that is designed to hold micro-plates. A six-drawer Stack holds 12 standard microplates, two in each drawer. A three-drawer Stack holds six deep-well micro-plates, two in each drawer.

PAL Object Manager

Software to load a PAL Object List to an instrument if a Module (hardware module) has been added to the PAL System. In a special mode Object Manager can also be used to create and maintain Object Lists.

PAL Object List

If a PAL Module (hardware) is added to an instrument, several Objects have to be loaded into the firmware. These Objects are collected in an Object List and stored in a file with the extension "*.pol".

Object Lists are delivered together with Object Manager Software and are grouped into folders for the different kind of Modules (e.g. Syringes, Tray Holders, Valve Drives). The name of an Object List starts with the Module part number with variants added (e.g. first or second Stack). The name of the root folder includes the revision which is dependent on the firmware version (e.g. "Object Lists Rev. K" for firmware 2.X and 3.X).

Object Class

Each Object belongs to an Object Class (e.g. Syringes, Trays, Injectors). The Object Class defines the Items of an Object.

Object Item

An Object contains several Items which can be numerical values with a physical unit (e.g. X-, Y-, Z-Position, Penetration, Syringe Scale Length, Syringe Volume) or references to other objects.

Note that the term "Parameter" is reserved for "ATOM Parameter" (PAL Firmware commands to be used for a PAL Cycle or Macro).

Objects

Objects are data structures describing the properties of physical modules. Certain modules (e.g. a Stack) require several objects.

Module

PAL hardware module, either part of a standard PAL configuration (e.g. COMBI PAL, HTS PAL) or an optional addition (e.g. Cooled Stack, MALDI Tool, Dilutor). The term “Module” is intentionally used to differentiate from “Object”, which is reserved for the PAL Firmware Object.

2. Naming Convention

This section recommends the standard naming convention for HTS PAL Trays, Tray Types, and Tray holders. Following these conventions will allow the HTS PAL to be pre-configured for certain applications, will simplify software backups and application development, and will improve technical support and training.

Tray Type	Tray Description
VT200	Vial Tray, 200 positions (10 x 20) For 7 mm micro-vials, 1 mL
VT98	Vial Trays, 98 positions (7 x 14) For 12 mm vials, 2 mL
VT78	Vial Tray, 78 positions (6 x 13) For 7 mm micro-vials, 1 mL (opposite side of 98 positions Tray)
VT54	Vial Tray, 54 positions (6 x 9) For 12 mm vials, 2 mL
VT21	Vial Tray, 21 Positions (7 x 14) For 12 mm vials, 2 mL (opposite side of 32 positions Tray)
VT32-10	Vial Tray, 32 positions (4 x 8) For 23 mm headspace vials, 10 mL
VT32-20	Vial Tray, 32 positions (4 x 8) For 23 mm headspace vials, 20 mL
MT96	Standard 96-position shallow microplate
DW96	Deep well 96-position microplate
MT384	High density 384-position shallow microplate

3. HTS PAL and -*xt* Injection Cycles

3.1. HTS PAL and -*xt* "LC-Inj" Cycle

No.	Processing Step	Method Parameter	Object (Class)	Used Object Value
1	Reference X, Y, Z axes and syringe plunger		(System)	Start Ref = ON
2	Wait for start signal		Start (Sync Signals)	
3	Read Barcode if enabled		TRAY (Tray Type)	Barcode $\neq$ None
4	Syringe wash strokes with solvent from Wash1	Pre Cln Slv1	SYRINGE (Syringes) Wash1 (Wash Stations)	Fill Speed Eject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
5	Syringe wash strokes with solvent from Wash2	Pre Cln Slv2	SYRINGE (Syringes) Wash2 (Wash Stations)	Fill Speed Eject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
6	Rinse syringe with sample selected number of times	Pre Cln Spl Sample Volume Fill Speed Pullup Delay	SYRINGE (Syringes) TRAY (Tray Type) Waste (Injectors)	Eject Speed Fill Volume Needle Penetr Needle Penetr
7	Fill syringe with sample using several filling strokes; aspirate air outside of vial if Air Volume > 0	Sample Volume Air Volume Fill Speed Fill Strokes Pullup Del	SYRINGE (Syringes) TRAY (Tray Type)	Eject Speed Overfill Fill Volume Needle Penetr
8	Move to injection valve	Inject to		
9	Wait for Inject signal		Inject (Sync Signals)	
10	Drive needle to penetration depth	Inject to	(Injectors)	Needle Penetr
11	Delay	Pre Inj Del		
12	Switch valve to Active position			
13	Activate Injected signal		Injected (Out Signals)	Pulse Time
14	Activate Injectd+Signal		Injectd+ (Out Signals)	Pulse Time
15	Dispense syringe contents into sample loop	Inject Speed		
16	Delay	Pst Inj Del		
17	Switch valve to Standby position			
18	Retract needle from injector			
19	Clean syringe and needle with solvent from Wash1	Pst Cln Slv1	SYRINGE (Syringes) Wash1 (Wash Stations)	Fill Speed Eject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
20	Clean syringe and needle with solvent from Wash2	Pst Cln Slv2	SYRINGE (Syringes) Wash2 (Wash Stations)	Fill Speed Eject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
21	Rinse valve inlet with solvent from Wash1	Vlv Cln Slv1	SYRINGE (Syringes) Wash1 (Wash Stations)	Fill Speed Inject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
22	Rinse valve inlet with solvent from Wash2	Vlv Cln Slv2	SYRINGE (Syringes) Wash1 (Wash Stations)	Fill Speed Inject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
23	Move to Home position		Home (Positions)	

3.1.1.1. "LC-Inj" Cycle Method Parameter Description

Parameter	Description
CYCLE	LC-Inj Cycle
SYRINGE	Selected syringe
Sample Volume	Selected sample volume
Air Volume	Volume aspirated after the syringe needle is moved out of the sample liquid
Pre Cln Slv1	Pre injection syringe wash strokes with solvent from Wash1
Pre Cln Slv2	Pre injection syringe wash strokes with solvent from Wash2
Pre Cln Spl	Pre injection syringe rinse cycles with sample
Fill Speed	Speed of plunger movement used to aspirate sample
Fill Strokes	Number of filling strokes to aspirate sample
Pullup Del	Delay time between sample pull-up and ejection
Inject to	Name of Injector used for injection
Inject Speed	Speed of plunger movement used during sample injection
Pre Inj Del	Delay time prior to sample injection
Pst Inj Del	Delay time after sample injection
Pst Cln Slv1	Post injection syringe wash strokes with solvent from Wash1
Pst Cln Slv2	Post injection syringe wash strokes with solvent from Wash2
Vlv Cln Slv1	Valve rinse cycles with solvent from Wash1
Vlv Cln Slv2	Valve rinse cycles with solvent from Wash2

3.2. HTS PAL and -*xt* "LC-Cut" Cycle

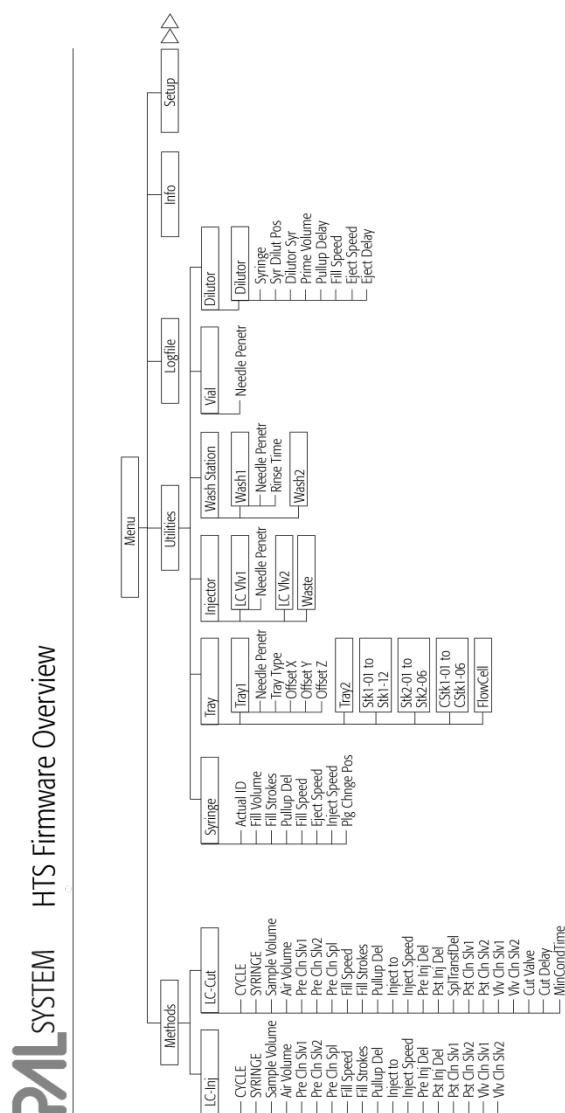
No.	Processing Step	Method Parameter	Object (Class)	Used Object Value
1	Reference X, Y, Z axes and syringe plunger		(System)	Start Ref = ON
2	Initialize injection valve: If SplTrnsfDel = 0 then switch to STANDBY (INJECT) else switch to ACTIVE (LOAD)	Inject to SplTrnsfDel	(Injectors)	
3	Initialize cut valve: If Cut Time > 0 then switch to STANDBY	Cut Valve Cut Time	(Injectors)	
4	Start timer "MinCondTime"	MinCondTime		
5	Wait for Start signal		Start (Sync Signals)	
6	Read Barcode if enabled		TRAY (Tray Type)	Barcode None
7	Syringe wash strokes with solvent from Wash1	Pre Cln Slv1	SYRINGE (Syringes) Wash1 (Wash Stations)	Fill Speed Eject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
8	Syringe wash strokes with solvent from Wash2	Pre Cln Slv2	SYRINGE (Syringes) Wash2 (Wash Stations)	Fill Speed Eject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
9	Rinse syringe with sample selected number of times	Pre Cln Spl Sample Volume Fill Speed Pullup Delay	SYRINGE (Syringes) TRAY Waste (Tray Type) (Injectors)	Eject Speed Fill Volume Needle Penetr Needle Penetr
10	Wait for timer "MinCondTime" elapsed to Zero	MinCondTime		
11	Fill syringe with sample using several filling strokes; aspirate air outside of vial if Air Volume > 0	Sample Volume Air Volume Fill Speed Fill Strokes Pullup Del	SYRINGE (Syringes) TRAY (Tray Type)	Eject Speed Overfill Fill Volume Needle Penetr
12	Move to injection valve	Inject to	(Injectors)	
13	Wait for Inject signal		Inject (Sync Signals)	
14	Drive needle to penetration depth	Inject to	(Injectors)	Needle Penetr
15	If SplTrnsfDel = 0 then switch injection valve to ACTIVE (LOAD) position	Inject to SplTrnsfDel	(Injectors)	
16	Wait for Pre Injection Delay	Pre Inj Del		
17	Dispense syringe contents into sample loop	Inject Speed		
18	Wait for Post Injection Delay	Pst Inj Del		
19	Switch Valve to STANDBY (INJECT) position. If SplTrnsfDel > 0 then switch valve back to ACTIVE (LOAD) after time SplTrnsfDel has expired.	Inject to SplTrnsfDel	(Injectors)	
20	Activate Injected Signal (System InjSignal = ValveSw)		Injected (Out Signals)	If Pulse Time =0, min. Pulse Time of 300 ms. is used. Can be extended with "Pulse Time"
21	Start timer "Cut Delay"			
22	Retract needle from injector			

No.	Processing Step	Method Parameter	Object (Class)	Used Object Value
23	Clean syringe and needle with solvent from Wash1	Pst Cln Slv1	SYRINGE (Syringes) Wash1 (Wash Stations)	Fill Speed Eject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
24	Clean syringe and needle with solvent from Wash2	Pst Cln Slv2	SYRINGE (Syringes) Wash2 (Wash Stations)	Fill Speed Eject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
25	Rinse valve inlet with solvent from Wash1	Vlv Cln Slv1	SYRINGE (Syringes) Wash1 (Wash Stations)	Fill Speed Inject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
26	Rinse valve inlet with solvent from Wash2	Vlv Cln Slv2	SYRINGE (Syringes) Wash1 (Wash Stations)	Fill Speed Inject Speed Needle Penetr Clean Volume Max Fill Speed Max Eject Speed
27	Wait for timer "Cut Delay" elapsed to Zero	Cut Delay		These two steps are executed concurrent with the wash steps.
28	If Cut Time = 0 then toggle Cut Valve position else Switch Cut Valve to ACTIVE Wait for time Cut Time Switch Cut Valve to STANDBY	Cut Time Cut Valve	(Injectors)	
29	Move to Home position		Home (Positions)	

3.2.1. LC-Cut" Cycle Parameter Description

Parameter	Description
CYCLE	LC-Cut Cycle
SYRINGE	Selected syringe
Sample Volume	Selected sample volume
Air Volume	Volume aspirated after the syringe needle is moved out of the sample liquid
Pre Cln Slv1	Pre injection syringe wash strokes with solvent from Wash1
Pre Cln Slv2	Pre injection syringe wash strokes with solvent from Wash2
Pre Cln Spl	Pre injection syringe rinse cycles with sample
Fill Speed	Speed of plunger movement used to aspirate sample
Fill Strokes	Number of filling strokes to aspirate sample
Pullup Del	Delay time between sample pull-up and ejection
Inject to	Name of Injector used for injection
Inject Speed	Speed of plunger movement used during sample injection
Pre Inj Del	Delay time prior to sample injection
Pst Inj Del	Delay time after sample injection
SplTransfDel	Time needed to transfer sample from Loop onto 2 nd valve (pre- or analytical column)
Pst Cln Slv1	Post injection syringe wash strokes with solvent from Wash1
Pst Cln Slv2	Post injection syringe wash strokes with solvent from Wash2
Vlv Cln Slv1	Valve rinse cycles with solvent from Wash1
Vlv Cln Slv2	Valve rinse cycles with solvent from Wash2
Cut Valve	Specify name of 2 nd valve, switching valve
Cut Delay	Time needed for clean-up. Switch to backflush sample, to analytical column or detector
MinCondTime	Minimum Conditioning Time: Time needed to condition pre-column on 2 nd valve

4.1. HTS PAL Flow Chart based on PAL Firmware Version 2.5.X.

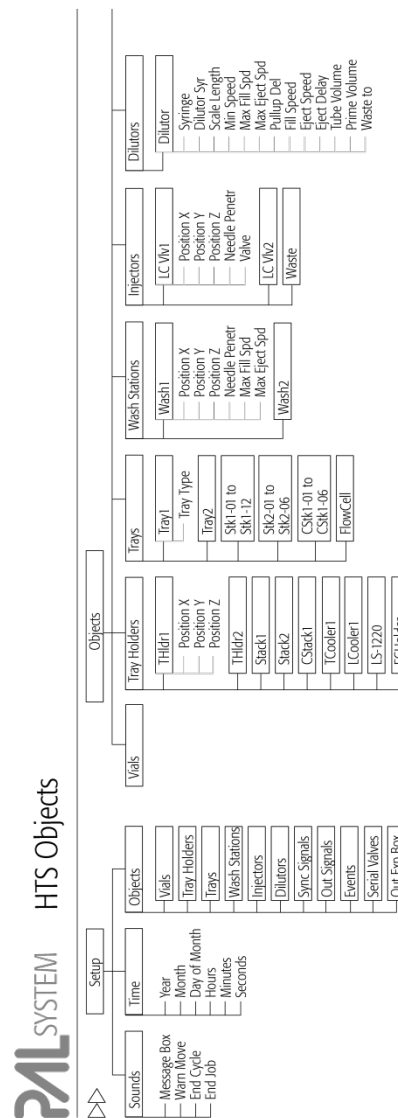


Notes:
Plunger Stroke and Valve Switch Counter
Menu/Info/Maintenance

The standard software does not include every object in the overview. The layout depends on the hardware configuration for each individual PAL-System

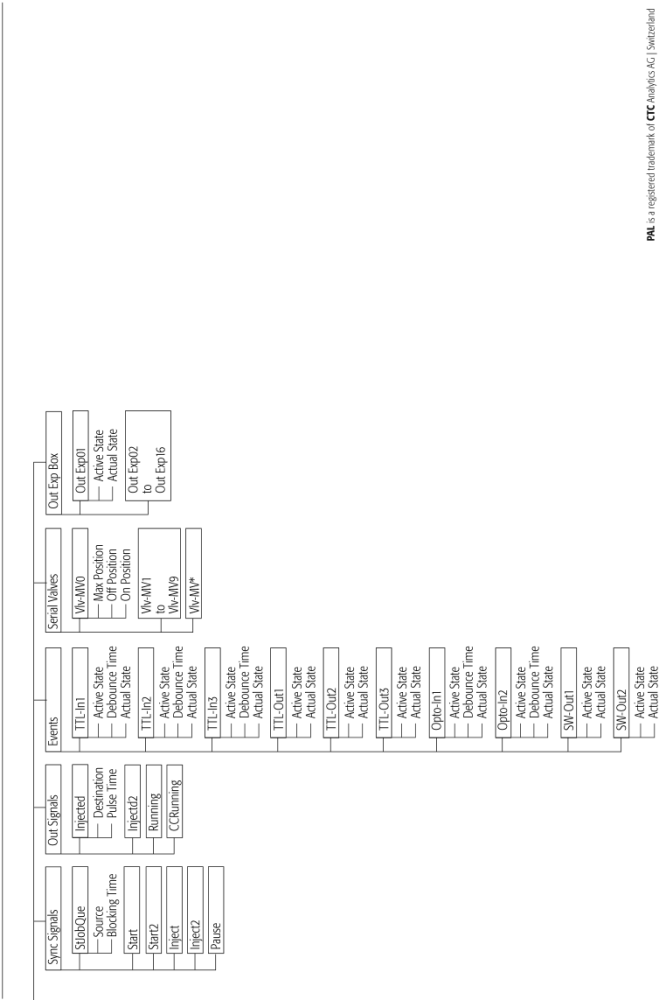
Revision G / Firmware 2.5.2 / June 2009

Figure 69. HTS PAL- Firmware Overview, Page 1



Note:
The standard software does not include every object as shown in the overview.
The layout depends on the hardware configuration for each individual PAL-System
Revision G / Firmware 2.5.2 / June 2009

Figure 70. HTS PAL Firmware Overview, Page 2

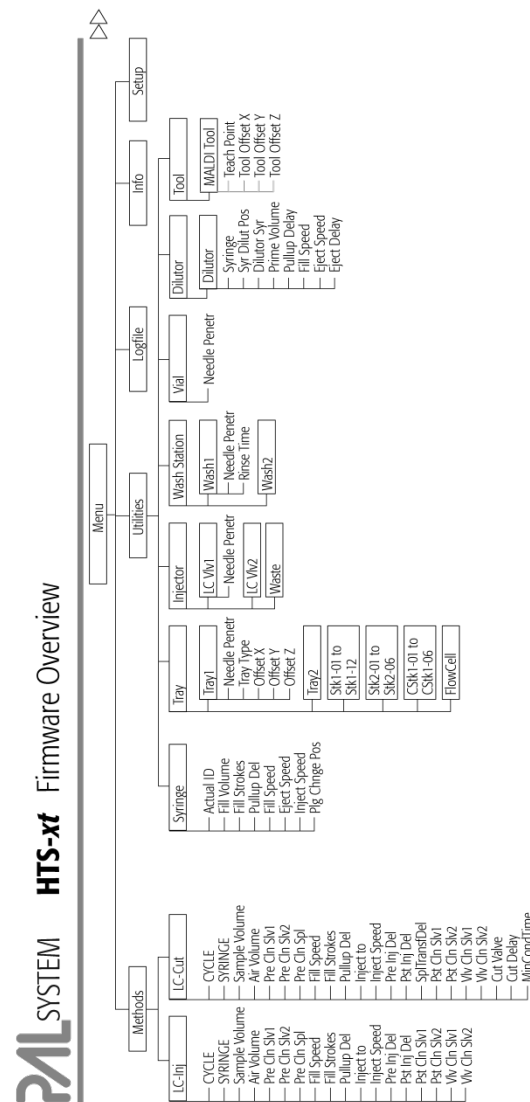


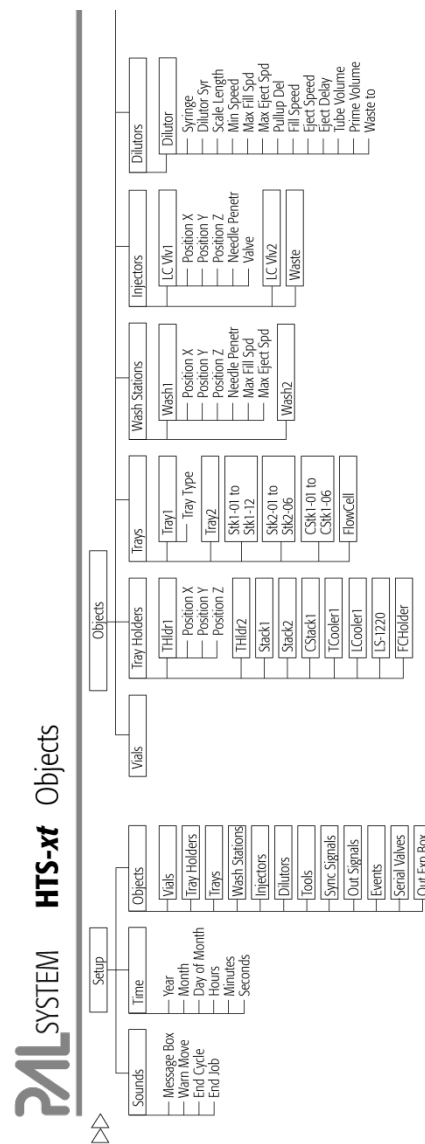
PAL is a registered trademark of CTC Analytics AG | Switzerland

Figure 71. HTS PAL Firmware Overview, Page 3

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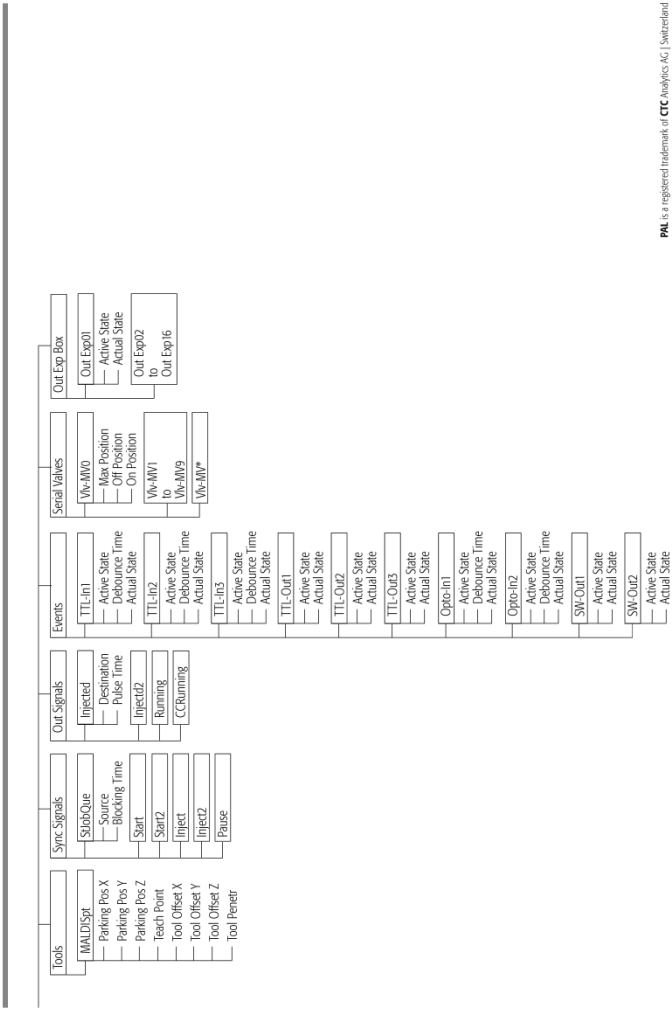
PAL is a registered trademark of **CTC** Analytics AG | Switzerland

4.2. PAL HTS-*xt* System Flow Chart based on
PAL Firmware Version 4.1.X*xt*
System,**note***Firmware version 4.1.X, as shown in the flow chart, corresponds to the PAL - System. The changes from Firmware version 2.5.X, as used for the PAL are emphasized in this PAL User Manual.***Notes:**
1. The standard software does not include every Object as shown in the overview.
The layout depends on the hardware configuration for each individual PAL-System.
Revision H / Firmware 4.0.X / June 2009Figure 73. PAL HTS-*xt* Firmware Overview, Page 1



Note:
The standard software does not include every Object as shown in the overview.
The layout depends on the hardware configuration for each individual PAL-System
Revision 14 / Firmware 4.0.X / June 2019

Figure 74 PAL HTS-xt Firmware Overview, Page 2



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Figure 75. PAL HTS-*xt* Firmware Overview, page 3

Method Cycle	Recommended PAL Method Parameters	Remarks
LC-Inj	LC-Inj	
CYCLE	LC-Cut	
SYNCE	100 µl	
Sample Volume	80 µl	
Air Volume	0 ml	
Pre-Cln SW1	1	
Pre-Cln SW2	0	
Pre-Cln Spd	2	
Fill Speed	5 µl/s	
Fill Strokes	3	
Pullup Del	3.10 s	
Injct to	LC-Vw 1	
Injct Speed	10 µl/s	
Pre-Inj Del	500 ms	
PS Inj Del	500 ms	
PS Cln SW1	2	
PS Cln SW2	0	
Wv Cln SW1	2	
Wv Cln SW2	0	
Cut Valve	LC-Vw 2	
Min/CondTime		
		Specify name of 2nd valve, switching valve
		Time needed for clean-up. Switch to backflush sample to analytical column or detector
		Minimum Conditioning Time: Time needed to condition pre- column on 2nd valve

LC-Cut Cycle controls 2 valves.

LC Valve 1: Injection valve with loop.

LC Valve 2: Switching valve.

Example 1: Pre- and Post Washing: Column for sample clean-up, backflushing to analytical column. Cut Delay > 0.

Example 2: Pre- and Post Washing: Column for sample clean-up, backflushing to analytical column. Load column 2.

Valve Toggle after cycle time. Loading column 2, condition column 1. Cut Delay = 0

LC Valve 1: Injection valve with loop.

LC Valve 2: Switching valve.

Example 1: Pre- and Post Washing: Column for sample clean-up, backflushing to analytical column. Cut Delay > 0.

Example 2: Pre- and Post Washing: Column for sample clean-up, backflushing to analytical column. Load column 2.

Valve Toggle after cycle time. Loading column 2, condition column 1. Cut Delay = 0

Example for the following conditions:

Loop Size 20 µl, overall 3 - 5 times

Partial Looping: Allowed sample volume range 20 - 60% of loop content for loops ≤ 100 µl

Large Loops: ≥ 80% of loop content

Syringe:

Syr X Cln00 - 225 - 3: Gauge 225 limits fill speed to max 20 µl/s (5-20 µl/s depends on viscosity of solvent)

Syr X Cln00 - 22 - 3: Gauge 22 allows fill speed up to 200 µl/s (depends on viscosity of solvent)

Effect speed for 100 µl Syringe: 50 to 150 µl/s (Utilities/Syringe)

Pre- and Post Washing:

Use solvent 1 and 2 for samples with components of extremely different polarities.

Samples containing proteins should not contact organic solvents.

Wash Steps for biological samples:

1st Wash Cycle: Aqueous solvent

2nd Wash Cycle: Organic solvent

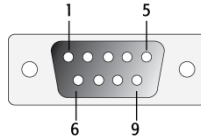
1st Wash Cycle before next sample

Pre-wash with aqueous solvent (eliminate organic solvents in Syringe and Valve)

Figure 76. PAL HTS-*xt* Firmware Overview, Page 4

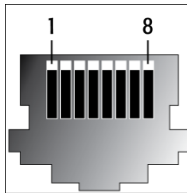
5. External Connectors for PAL and -*xt* System

Connector SER1 | PAL and -*xt* System



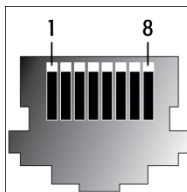
Pin	Signal Name
1	NC
2	RXD
3	TXD
4	DTR bridged with Pin7; Special grounding, do not alter.
5	GND
6	NC
7	RTS bridged with Pin 4; Do not alter.
8	NC
9	NC

Connector TERMINAL or SER3 | PAL and -*xt* System



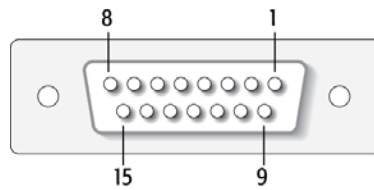
Pin	Signal Name
1	GND
2	RXD
3	TXD
4	NC
5	NC
6	+5V
7	NC
8	GND

Connector SER2 | PAL System



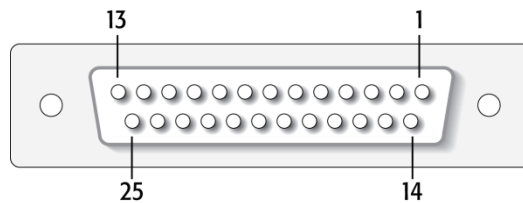
Pin	Signal Name
1	GND
2	RXD
3	TXD
4	NC
5	NC
6	+5V
7	NC
8	GND

Connector INTERFACE 1 | PAL and -*xt*System



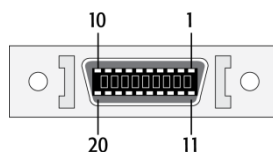
Pin	Signal Name
1	Pwr-Out1 +
2	Pwr-Out2 +
3	SW-Out1 NO
4	SW-Out1 COM
5	SW-Out2 NO
6	Opto-In1 +
7	TTL-In1
8	GND
9	Pwr-Out1 -
10	Pwr-Out2 -
11	TTL-In2
12	SW-Out2 COM
13	TTL-In3
14	Opto-In1 -
15	+5V

Connector INTERFACE 2 | PAL and -*xt*System



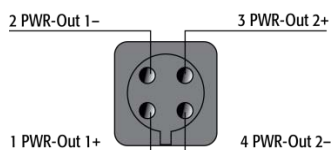
Pin	Signal Name
1	TTL-In1
2	TTL-In2
3	TTL-In3
4	TTL-Out1
5	TTL-Out2
6	TTL-Out3
7	Opto-In1 +
8	Opto-In2 +
9	SW-Out1 NO
10	SW-Out2 NO
11	Pwr-Out1 +
12	Pwr-Out2 +
13	+5V
14-19	GND
20	Opto-In1 -
21	Opto-In2 -
22	SW-Out1 COM
23	SW-Out2 COM
24	Pwr-Out1 -
25	Pwr-Out2 -

Connector AUX1; AUX2 | PAL and -*xt*System



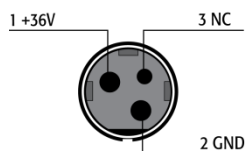
Pin	Signal Name
1,2	Motor A1
11,12	Motor A2
3,4	Motor B1
13,14	Motor B2
15,18,19	GND
6	Temp +
16	Temp -
7	Sens
17	+5V
8,9	Heater
20,10	36V

Connector Wash Station | PAL-*xt*System



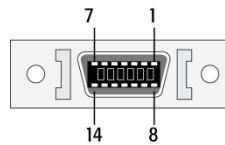
Pin	Signal Name
1	PWR – Out1+
2	PWR – Out1-
3	PWR – Out2+
4	PWR – Out2-

Connector Power | PAL and -*xt*System



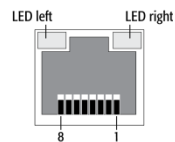
Pin	Signal Name
1	+36 V
2	GND
3	NC

Connector MODBUS | PAL-*xt* System



Pin	Signal Name
1	TXD
2 – 7	+36 V
8	RXD
9 – 14	GND

Connector LAN | PAL-*xt* System



Pin	Signal Name	DIR	Primary Function
1	TX+	Out	Transmit Data +
2	TX-	Out	Transmit Data -
3	RX+	In	Receive Data +
4,5,	Not used		Terminated
6	RX-	In	Receive Data -
7,8	Not used		Terminated

Connector Fuse | PAL-*xt* System

Fuse Type	FST 5x20
Rating	6.3A
Rated Voltage	250 VAC

6. Intended Use for PAL System

6.1. Introduction

The brand name "PAL System" represents an entire product family, the following description of intended use therefore applying to the product groups "PAL" and "PAL-*xt*", which include for example the models Combi PAL, HTS PAL or PAL Combi-*xt* and PAL HTS-*xt* together with other PAL/PAL-*xt* design-dependent subclasses.

If the PAL System is distributed through OEM partners, the product or model name can be replaced with their own name but the "Intended Use" remains valid.

6.2. Intended Use

The PAL System is an XYZ robotic system offering high flexibility and functionality. Its intended use can be described as being mainly as autosamplers or sample preparation devices for all relevant fields of application in chemical and physical analysis.

The systems will only be used by trained operators in a professional environment.

Typical fields of application for the PAL System are:

- Environmental analysis
- Quality control in the chemical and pharmaceutical industries
- Drug discovery
- Metabolism studies on agrochemicals or pharmaceutical products

The above list of typical applications is not exhaustive.

The traditional market position of CTC Analytics AG has resulted in the PAL System being mainly used as an autosampler device for the techniques of GC (gas chromatography) and HPLC (high pressure liquid chromatography). Sample preparation steps, such as filtration, purification or separation by means of solid phase extraction (SPE), derivatization, etc., are possible in combination with chromatographic or other techniques.

Other techniques or areas of application are also possible. XYZ robotic systems are typically used where vial (sample) transport, liquid handling or sample preparation need to be automated. Known fields of application include tablet dissolution and viscosimetry.

The users will to a large extent themselves determine which substances, compounds or liquids the system will come into contact with.

6.3. Disclaimer and Restrictions on Use

The PAL System boundary represents a significant limitation of the manufacturer's responsibility. Submitting and placing samples (vials, well plates or other sample holding devices), inserting syringes, selecting reagents and wash solvents are together with any other preparative tasks solely the responsibility of the user. Any possible sample mix-up or omission of an item cannot be detected or prevented by the PAL System. The PAL or PAL-*xt* System boundary is defined when the sample is placed in the system and by the final prepared and primed system.

The use of the PAL and PAL-*xt* Systems for any invasive technique on human beings or animals is explicitly excluded.

In addition, any application in an environment where explosion protection is required is specifically prohibited for the PAL and PAL-*xt* Systems.

7. PAL Accessories

The accessories for the PAL System are described in the attached "PAL accessories Catalog" or on the web page: www.ctc.ch.

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